E1701 Modular Scanner Controller

Users Manual

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2 History

Date	Changes in document
06/2024	Description of limitations of dynamic texts clarified
06/2024	Description of parameter "iothres" clarified
03/2024	Added parameter and command cswaf
01/2024	Description of E1701dock extended
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10/2023	Windows 11 Ethernet configuration description added
07/2023	Reference to header files and programming examples added
05/2023	HALdrive mounting position added to E170Xbase description
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12/2022	Description of E170X stop execution () and cvers extended
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10/2014	Output current values added, description for Secondary Head Extension added		
09/2014	Minor corrections in layout and text		
09/2014	Initial version		

3 Safety

The hardware described within this document is designed to control a laser scanner system. Laser radiation may effect a person's health or may otherwise cause damage. Prior to installation and operation compliance with all relevant safety regulations including additional hardware-controlled safety measures has to be secured. The client shall solely be responsible to strictly comply with all applicable and relevant safety regulations and operation of the system at any time.

Beside of that some laser equipment can be damaged in case it is controlled with wrong signals or signals outside a given specification. Thus it is highly recommended to check the output generated by this hardware using e.g. an oscilloscope to avoid problems caused by wrong configurations. This should be done prior to putting a system into operation for the first time, whenever some parameters have been changed or whenever any kind of software update was installed.

The hardware described here is shipped without any cover and without prefabricated equipment for electric installation. It is intended to be integrated in machines or other equipment. It is not a device for use "as is", but a component which is intended to be used as part of a larger device, e.g. for integration in a machine with own housing or within an electrical cabinet. Prior to operation compliance with all relevant electric / electromagnetic safety regulations including additional hardware-controlled safety measures has to be secured. The client shall solely be responsible to strictly comply with all applicable and relevant regulations regarding installation and operation of the system at any time.

The hardware described here is an electrostatic sensitive device. This means it can be damaged by common static charges which build up on people, tools and other non-conductors or semiconductors. To avoid such a damage, it has to be handled with care and including all relevant procedures (like proper grounding of people handling the hardware, shielding/covering to not to let a person touch the hardware unwanted, proper packaging in ESD-bags, ...). For more information please refer to related regulations and standards regarding handling of ESD devices. The EMC Directive (2014/30/EU) does not apply to this hardware as it is not intended for an end user (a person without knowledge of EMC) and as it is not otherwise made available on the market.

The Low Voltage Directive (2014/35/EU) does not apply to this hardware as the voltage supply is below the 50V AC / 75V DC limit.

This document describes the E1701-hardware but may contain errors or may be changed without further notice.

4 Overview

This document describes the E1701 modular scanner controller board family, their electrical characteristics and usage. They consist of E1701D XY2-100/XY3-100 scanner controller baseboard plus optional extension boards and of E1701A analogue scanner controller baseboard plus optional extension boards. Special variant E1701M is no scanner controller and therefore not covered by this document.

The E1701 scanner controller boards are designed for controlling galvanometric scanner systems with two or three axes. Depending on the used extension boards (which are optional) they also supply extensive signals for laser and external control. The communication between the host system and the controller boards is done via Ethernet or USB.

When using E1701 scanner controller boards, there is always one baseboard required for proper operation. This baseboard can be used together with different extension boards that provide additional signals for controlling the laser marking process. These extension boards are optional and have to be used only in environments where the additional signals processed by these boards are required. So depending on used type of laser and requirements, the minimal solution to control a laser marking system may consist of the baseboard only.

Normally extension boards can be combined with any baseboard and all other extension boards freely, there are no restrictions for usage. In case some specific extension board types can't be operated with other boards, this is stated in description of the related boards below.

Normally an E1701 baseboard can be combined with several extension boards of different types but not with more than one board of same type. In case of special extension boards where more than one board of the same type can be used, this is stated in description of the related board below.

4.1 Features

Following the features of available base- and extension boards are described

4.1.1 E1701D XY2-100/XY3-100 Digital Laser Scanner Controller Baseboard

This baseboard can be used to control 2D or 3D scanheads that come with a XY2-100, XY2-100-E or XY3-100 interface. It can be combined with extension boards without any restrictions. E1701D offers following features:

- XY2-100 interface to scanhead with X, Y and Z channel
- XY2-100-E interface to scanhead with X and Y channel
- XY3-100-E interface to scanhead with X and Y channel
- 100 Mbit Ethernet connection
- USB 2.0 connection
- online XYZ grid correction with support for several correction table file formats (like SCAPS[™] .ucf, Scanlab[™] .ctb and .ct5, Raylase[™] .gcd, Rofin[™] .fcr, Han's[™] .crt, CTI[™] .xml or Sunny[™] .txt)
- high-definition online XYZ grid correction with BeamConstruct HD correction files (.bco)
- fast switching between up to 16 preloaded grid correction tables
- 10 microseconds vector cycle time and resolution (microstep period)
- command execution time down to 0,5 microseconds
- realtime processing of laser and scanner signals
- 26 bit internal resolution (for better quality also with 16 or 18 bit hardware output)
- can control nearly every laser type (this may require extension boards as described below)
- two laser CMOS digital outputs for usage with YAG, CO2, IPG(tm) and compatible laser types (outputs can provide PWM frequency, Q-Switch, FPK-pulse, CW/continuously running frequency, stand-by frequency) running with frequencies of up to 20 MHz
- 512 MByte DDR3 RAM
- 1 GHz CPU clock
- support for microSD and microSDHC cards
- internal command and vector data list with more than 17 million entries
- continuous list concept, no need to swap between buffers
- BeamConstruct PRO license included

 open source compatibility library that emulates existing programming interface for fast and easy usage with existing software (contains e.g. Scanlab(tm) RTC4(tm), SCAPS(tm) USC(TM)/SCI and other compatible interfaces)

4.1.2 E1701A Analogue Laser Scanner Controller Baseboard

This baseboard can be used to control 2D scanheads that come with an analogue control interface. It can be combined with all extension boards except Secondary Head Extension. E1701A offers following features:

- +-5V / +-10V bit analogue interface with 16 bit resolution each to control scanheads with X and Y channel
- 3x +5V analogue output with 12 bit resolution each
- 100 Mbit Ethernet connection
- USB 2.0 connection
- online XY grid correction with support for several correction table file formats (like SCAPS[™] .ucf, Scanlab[™] .ctb and .ct5, Raylase[™] .gcd, Rofin[™] .fcr, Han's[™] .crt, CTI[™] .xml or Sunny[™] .txt)
- high-definition online XY grid correction with BeamConstruct HD correction files (.bco)
- fast switching between up to 16 preloaded grid correction tables
- 10 microseconds vector cycle time and resolution (microstep period)
- command execution time down to 0,5 microseconds
- realtime processing of laser and scanner signals
- 26 bit internal resolution (for better quality also with 16 bit hardware output)
- can control nearly every laser type (this may require extension boards as described below)
- 512 MByte DDR3 RAM
- 1 GHz CPU clock
- support for microSD and microSDHC cards
- internal command and vector data list with more than 17 million entries
- continuous list concept, no need to swap between buffers
- BeamConstruct PRO license included
- open source compatibility library that emulates existing programming interface for fast and easy usage with existing software (contains e.g. Scanlab(tm) RTC4(tm), SCAPS(tm) USC(TM)/SCI and other compatible interfaces)

4.1.3 E1701 LP8 Extension Board

This board can be used to provide signals for controlling a wide range of laser types. It offers following features:

- LP8 8 bit CMOS level parallel digital output e.g. for controlling laser power
- LP8 latch CMOS level digital output for usage with IPG(tm) and compatible laser types
- Main Oscillator CMOS level digital output for usage with IPG(tm) and compatible laser types
- 8 bit 0..5V analogue output e.g. for controlling laser power (this output depends on LP8 outputs directly)
- two laser CMOS level digital outputs for usage with YAG, CO2, IPG(tm), SPI(tm) and compatible laser types (outputs can provide PWM frequency, Q-Switch, FPK-pulse, CW/continuously running frequency, stand-by frequency) running with frequencies of up to 20 MHz

4.1.4 E1701 Digi I/O Extension Board

This board provides additional digital in- and outputs for synchronisation and communication with external equipment. It offers following features:

- 8 freely usable digital outputs providing either CMOS level or electrically insulated outputs via external power supply
- 8 freely usable digital inputs expecting either CMOS level or electrically insulated inputs via external power supply
- 2 digital inputs usable for quadrature encoder signals for marking on-the-fly applications

4.1.5 E1701 Secondary Head Extension Board

Using boards of this type additional heads can be connected which then work in parallel to the first scanhead of E1701D baseboard. As output-only device it provides an additional XY2-100 or XY3-100 connection. This extension can't be used with E1701A baseboard.

5 Position Within The System

The E1701 scanner controller system can be connected to the host via Ethernet or USB to receive laser marking data from BeamConstruct laser marking application or from any other application which makes use of one of the provided programming possibilities (as described below). When using Ethernet connection, it optionally can be connected via USB too. In this case USB connection is used to retrieve BeamConstruct PRO license from the board:



Since 100 Mbit Ethernet provides much faster data transfer than USB 2.0, this connection type is preferred. Especially in case complex marking data with many short lines that result in many separate jump and mark commands are used, Ethernet connection is more responsive.

When using USB connection with such data, time from sending data to the card until marking operation can be started may be longer (up to several seconds in worst case) caused by slower USB data transfer:



In both cases the board itself is connected with the scanhead to submit 2D or 3D position information to it. Beside of that it is connected to a laser to submit motion-synchronous laser data. Additional communication channels between the E1701 scanner controller board and a connected machine can be done via separate IOs of an extension board.

6 Boards And Connectors

6.1 E1701D XY2-100/XY3-100 Digital Laser Scanner Controller Baseboard



The E1701D Digital Laser Scanner Controller Baseboard provides following connectors and interfaces:

- 1. Ethernet for communication with the host system, marking information are submitted via this path
- 2. USB via miniUSB connector for providing BeamConstruct PRO license to host system and optionally for submitting marking data from host to E1701D card (in case Ethernet is not used)
- 3. Power connect with power jack 5V DC
- 4. Power LED lights when power is available
- 5. User LEDs show operational and error states of card
- 6. Laser LED shows modulation state of laser
- 7. Reset-button on-board button to restart the board completely
- 8. microSD-card (on bottom side) storage place for firmware and extended configuration file, can be used to upgrade firmware, to change the card's IP and other things more
- 9. Laser/Scanner signals <u>white</u> 26 pin laser and scanner output connector which provides XY2-100 / XY2-100-E scanner signals as well as laser and marking control IOs
- 10. Extension connectors extension boards can be placed here in order to add some more functionality and hardware interfaces to the board

6.1.1 Ethernet

This is a standard RJ45 Ethernet plug for connection of the board with the host system. The controller board is accessed via this connection, all scanner and laser data are sent via Ethernet. Thus it is recommended for security reasons to have a separate 1:1 connection from the host to the scanner controller card by using a separate Ethernet port. In case this is not possible at least an own, physically separated sub-net for all scanner controller cards should be set up. This network of course should be separated from normal network completely. Ethernet connection is initialised during start-up, thus Ethernet cable connecting E1701 board and host system needs to be plugged <u>before</u> the board is powered up.

By default the E1701 baseboard is using IP 192.168.2.254, thus the Ethernet network the card is connected with needs to belong to subnet 192.168.2.0/24.

PLEASE NOTE: For security reasons it is highly recommended to not to mix a standard communication network with an E1701 network or to connect the scanner controller card with a standard network. Here it may be possible someone else in that network (accidentally) connects to that scanner controller and causes laser emission.

The IP of the scanner controller can be changed. This is necessary e.g. in case an other subnet has to be used or in case the E1701 board has to be operated in multi-head environments where more than one card will be accessed at the same time. The IP can be configured using e1701.cfg configuration file that is placed on microSD-card. To change the IP please perform the following steps:

1. disconnect E1701 board from power and USB

- 2. remove microSD-card
- 3. put microSD-card into a desktop computer, this may require a microSD- to SD-card-adapter
- 4. open the drive that is assigned to the card
- 5. open file e1701.cfg using a text editor like Notepad or kwrite
- 6. add a line or edit an existing line "ip1=", here the desired IP has to be appended (as example: when you want to configure IP 192.168.2.13 the line has to be "ip1=192.168.2.13" without any quotation signs
- 7. save the file
- 8. eject the drive the card is assigned to
- 9. place the microSD-card in E1701 board (place without the use of force, notice correct orientation with connectors of microSD-card to bottom!)
- 10. power up card

When User LEDs do not light up as described below, please check if microSD-card is placed in board correctly.

6.1.1.1 Ethernet Configuration With Windows 10

When E1701 scanner controller is accessed via Ethernet, it is recommended to have a 1:1 connection to the host PC for security reasons. Since the controller is working with a static IP (default is 192.168.2.254) the Ethernet port on host PC has to be configured with an IP of same subnet in order to allow access to it. For Windows 10 (and similar) this configuration has to be done using following steps:

- 1. right-click the network-symbol in your taskbar
- 2. Select "Open network and internet settings"
- 3. Select "Ethernet" on the left
- 4. find the network interface E1701D has to be connected with and select it
- 5. Click the "Edit" button in section "IP settings"
- 6. now a window opens where "IPv4" has to be turned on and that has to be configured as follows:

Edit IP settings	
Manual	\sim
IPv4	
On On	
IP address	
192.168.2.161	
	k
Subnet prefix length	
24	
Gateway	
192.168.2.2	
Preferred DNS	
Alternative DNS	
IPv6	
Save	Cancel

There you can specify an IP for your host PC. It has to belong to network 192.168.2.xxx and can be any number except than 192.168.2.254 (this is already the IP of the scanner card), 192.168.2.0 or 192.168.2.255.

6.1.1.2 Ethernet Configuration With Windows 11

When E1701 scanner controller is accessed via Ethernet, it is recommended to have a 1:1 connection to the host PC for security reasons. Since the controller is working with a static IP (default is 192.168.2.254) the

Ethernet port on host PC has to be configured with an IP of same subnet in order to allow access to it. For Windows 10 (and similar) this configuration has to be done using following steps:

- 7. right-click the network-symbol in your taskbar
- 8. Select "Network and internet settings"
- 9. Select "Ethernet" in the opened list
- 10. find the network interface E1701D has to be connected with and select it
- 11. Click the "Edit" button right beside "IP assignment"
- 12. now a window opens where "Edit IP Settings" has to be switched from "Automatic (DHCP)" to "Manual"
- 13. next "IPv4" has to be turned on and the remaining parameters in this window have to be configured as follows:

Manual	~
IPv4	
On IP address	
192.168.2.161	
Subnet mask	
255.255.255.0	
Gateway	
192.168.2.2	
Preferred DNS	
192.168.2.2	
DNS over HTTPS	
Off	~
Alternative DNS	
Save	Cancel

There you can specify an IP for your host PC. It has to belong to network 192.168.2.xxx and can be any number except than 192.168.2.254 (this is already the IP of the scanner card), 192.168.2.0 or 192.168.2.255.

6.1.1.3 Ethernet Configuration With Linux

When E1701D scanner controller is accessed via Ethernet, it is recommended to have a 1:1 connection to the host PC for security reasons. Since the controller is working with a static IP (default is 192.168.2.254) the Ethernet port on host PC has to be configured with an IP of same subnet in order to allow access to it. For Linux (with NetworkManager) this configuration has to be done using following steps:

- 1. right-click the network-symbol in taskbar
- 2. click "Edit Connections..."
- 3. select the "Wired" network interface the scanner card is connected with and press button "Edit"

4. go to tab-pane "IPv4 Settings" and configure it as shown below:

Editing Auto eth0 ×			
Connection name: Auto eth0			
✓ Connect automatically			
✓ Available to all users			
Wired 802.1x Security IPv4 Settings IPv6 Settings			
Method: Manual			
Addresses			
Address Netmask Gateway Add			
192.168.2.117 255.255.255.0 0.0.0.0 Delete			
DNS servers:			
Search domains:			
DHCP client ID:			
☑ Require IPv4 addressing for this connection to complete			
Routes			
Cancel Apply			

There you can specify an IP for your host PC. It has to belong to network 192.168.2.xxx and can be any number except than 192.168.2.254 (this is already the IP of the scanner card), 192.168.2.0 or 192.168.2.255.

6.1.2 USB

This is a standard miniUSB-connector for connection of the board with the host system. It is used to retrieve BeamConstruct PRO license and optionally – when Ethernet is not connected – to send marking data to the card.

PLEASE NOTE: USB 2.0 is much slower than a standard 100 Mbit Ethernet connection, so expect slower execution in case of complex marking data!

Required device driver is installed together with installation of the HALsetup software package (Windows) or comes with operating system by default (Linux). E1701 card appears as COM-interface on Windows using any free number for the port. With Linux it appears as /dev/ttyACMx where "x" is any number. These numbers are provided by the operating system automatically.

By default USB provides 5V power supply too. So whenever card has to be stopped, both USB and power have to be disconnected in order to shut it down completely. It is not recommended to use USB as power supply, an additional, external power should be connected in order to operate E1701 controller correctly. Nevertheless it might be possible E1701 card can be operated on USB power only. Since this highly depends on the capabilities of used host system, it has to be evaluated for every particular case.

When the controller is connected via USB, a BeamConstruct PRO license is provided via this interface automatically. This is done without the need to configure anything, and as long as following conditions are true:

- physical USB connection from controller to host PC exists
- the COM-port (Windows) has a number smaller than COM20
- the controller is working and the Alive-LED in blinking

It is also possible to have the USB-connection for license retrieval only and to use the Ethernet-connection to transfer marking data to the controller, both can exist beside each other.

6.1.3 Power

Power supply for E1701 scanner controller board is done via power jack right beside Ethernet port. Power can be supplied via a 2.1 mm x 5.5 mm centre connector when connected to a positive power supply rated at 5V DC

+/- 0.1V and 2.5A (smoothed, positive pole on inner contact). Do not apply voltages in excess of 5V to the DC input. The DC power supply must be grounded.

To avoid high frequency interferences from other electrical equipment or from within the power supply, it is recommended to place a ferrite bead at the cable close to the board. Please also check for correct shielding in respect to the equipment the E1701 card is used within.

6.1.4 Power LED

This LED is lit as soon as the board is on some power. This means it <u>may be</u> functional and <u>could</u> emit any signals as soon as this LED is on but it does not necessarily need to work properly since firmware may not be started at this point. Please refer section below for LEDs that show functional state of the board.

6.1.5 User LEDs

The real operational state of the card is shown by four additional LEDs described here from inner to outer position:



1. Boot- and Alive-LED – this LED is turned on permanently as soon as the card was powered up and the firmware boots properly. When it is not turned on after some seconds please check if the microSD-card is placed properly and if it contains a working firmware file (for details please refer below). After boot process has completed successfully, it starts blinking slowly. This is an alive-notification, as long as it blinks, the board is working and ready for operation. During marking operations the blink frequency may go down. Only in case it does not blink for more than 20 seconds, the board has died for some reason and should be restarted.

Please note: during start-up and when the configuration parameter "eth=2" is set in e1701.cfg, the blinking frequency can be much slower. This is the case as long as the controller tries to detect an Ethernet connection. It ends and switches to faster blink frequency as soon as this detection is timed-out or as soon as a connection via Ethernet or USB is established.

- 2. Marking Active LED this LED is turned on as long as a marking operation is running. This LED does <u>not</u> correspond to the laser gate signal, comparing to it it's also enabled during jumps when laser is turned off but marking operation itself is active.
- 3. Stop LED this LED is lit as long as a valid external stop signal is detected.
- 4. Error-LED this LED is turned on in case a fatal error occurs that normally should never happen. When it is on, in most cases board can't continue with operation until the reason for error is removed and the board is restarted. In case this LED is turned on please:
 - check if you are using exactly one baseboard
 - check if you are using E1701 extension boards only (and no other 3rd party hardware)
 - check if you are using latest firmware and host software
 - check all connections and cables
 - undo your latest changes in hardware and configuration

If these steps do not help, please contact HALaser Systems for further assistance.

6.1.6 Laser LED

This LED shows modulation state of the laser and signal of laser gate output. It is turned on as long as the laser is turned on and the laser gate is high. This LED does NOT signal the same like the marking active LED described above since it will be turned off during jumps.

6.1.7 Reset-Button

When this button is pressed for at least 20 milliseconds, it restarts the card completely, a current marking operation is cancelled, all signals are disabled and all remaining marking data are dropped. After releasing this button, the board is rebooted and firmware is started again.

6.1.8 microSD-Card

The microSD card is storage place for firmware and configuration files. Here SD and SDHC cards with storage space of up to 32 GB are supported.

To remove the microSD-card, first disconnect all power from the E1701 board completely (including USB, Power LED has to go off). Next press microSD card gently into the board until you can hear a click-noise. Then you can pull it out of the board. To place a microSD card, the same has to be done in reverse order: place it into the E1701 board's card slot and press it gently until a noise signals locking of the card. Now the board can be powered.

E1701 baseboard is shipped with a card containing firmware and configuration files:

- E1701.fwi firmware file that is used to operate the board, to be replaced when a firmware update is provided
- E1701.cfg configuration text file, can be edited using a text editor in order to modify cards configuration
- E1701.dat additional data file that is used to operate the board, to be replaced when a firmware update is provided

To use an other microSD card than the one shipped with the board, following conditions have to be met:

- maximum total size of 32 GB (SD or SDHC card)
- FAT32 formatted
- using only one partition
- BOOT-flag is set
- E1701.fwi and e1701.dat file available on card

An additional file E1701.cfg can be placed on the card too. It contains plain ASCII text, acts as configuration file and can contain several parameters and its values which are separated by an equal-sign. Every of the possible parameter/value pairs has to be located in an own line. Following configuration parameters are possible within this file:

Parameter	Description	Example
ip1	Configures IP of Ethernet port. Here only IPs in xxx.xxx.xxx.xxx	ip1=192.168.2.100
	notation are allowed but no host or domain names.	specifies IP 192.168.2.100
		to be used for Ethernet
		interface on next startup
corrtable0	Specifies a correction table file in .ctb, .ct5, .ucf, .gcd, .xml, .crt, .txt	corrtable0=0:/
	or .bco format to be loaded on start-up. When this parameter is	D2_200.ctb
	set, the specified correction table is used exclusively and all	use file D2_200.ctb as
	correction data possibly sent from the host are ignored. The	correction file and ignore
	correction file itself has to be located on microSD-card too.	all correction tables
	This method has also to be used when running the controller in	possibly sent from host
	stand-alone mode with .EPR files that require such a correction.	application
	When the Error-LED is turned on after a correction table file was	
	configured, E1701 baseboard was not able to load it for some	
	reason.	
corrtable <i< td=""><td>Specifies one of up to 16 correction table file</td><td>corrtable7=0:/200_2</td></i<>	Specifies one of up to 16 correction table file	corrtable7=0:/200_2
dx>	in .ctb, .ct5, .ucf, .gcd, .xml, .crt, .txt or .bco format to be loaded on	00.bco
	start-up. When this parameter is set, the specified correction	use file 200_200.bco as

Parameter	Description	Example
	table is used exclusively and all correction data possibly sent	correction file at index
	from the host are ignored. The correction file itself has to be	position 7 and ignore all
	located on microSD-card too.	correction tables possibly
	This method has also to be used when running the controller in	sent from host application
	stand-alone mode with .EPR files that require such a correction.	
	When the Error-LED is turned on after a correction table file was	
	configured, E1701 baseboard was not able to load it for some	
	reason.	
	<idx> can be any value in range 015 and specifies the storage</idx>	
	location index of the correction file to be loaded. Later the	
	related correction file can be used via command cscor.	
	When has to be set to values greater than 0, a firmware	
	version 33 or newer is needed.	
passwd	Specifies an access password that is checked when card is	passwd=myCardPwd
	controlled via Ethernet connection. This password corresponds	set a password
	to password specified with function E170X_set_password(),	myCardPwd
	please refer below for a detailed description.	
	When a client computer connects to the card without sending	
	the correct password, Ethernet connection to this nost is closed	
	Initiation of the product of the pro	
\wedge	PLEASE NOTE. This password does not replace any network	
<u>· </u>	F1701 controller via insecure networks or Internet I It is	
	transferred unencrypted and therefore can be "backed" easily	
	Intention of this password is to avoid collisions between several	
	F1701 cards that operate in same network and are accessed by	
	several software instances.	
	Maximum allowed length of the password is 48 characters. It is	
	recommended to not to use any language-specific characters.	
standalone	This command can be used to disable or enable a specific stand-	
	alone operation mode. For a detailed description of possible	
	parameters, operation modes and usage please refer related	
	section below.	
iolatch	When using one of the digital-input-controlled stand-alone	iolatch=1
	modes, this option can be used to latch the digital states in via	enable the latch-function
	Din /. For details please refer to section "6.1.11 Stand-Alone	via Din7
iothree	Uperation below	ictbres-120000
lourres	In stand-alone mode there are two conditions that cause a	Set the threshold for
	marking huffer or a minimum amount of data is available in	availability of the stand-
	secondary buffer	alone marking data to
	Something similar is true for host-controlled operating mode	120000
	here marking starts when E170X execute () is called or when	
	a minimum amount of data has been transmitted to the	
	controller.	
	That minimum amount of marking data can be modified with the	
	parameter "iothres". The smaller this value is, the faster marking	
	will start, but in this case it also may happen there are not	
	enough data available so that interruptions occur during	
	marking. So a balance between speed and a secure, non-	
	interrupted marking process need to be found when this value is	
	modified.	
	By default "iothres" is 80000 which should fit to most	
	applications, the maximum allowed value is 280000 and it should	
	not become smaller than 10000	

Parameter	Description	Example
haltedloopt	This parameter is used in stand-alone modes "haltedloop" and	haltedlooptimeout=5
imeout	"iohaltedloop" (please refer to section "6.1.11 Stand-Alone	sets the laser timeout to 5
	Operation" for detailed information). It defines a timeout for the	seconds
	laser in unit seconds. If the current operation is active for a	
	longer time, the laser is turned off. It then can be turned on only	
	by toggling the enable-input (ExtStart) again.	
	This parameter requires firmware version 35 or newer.	
haltedloop	This parameter is used in stand-alone modes "haltedloop" and	haltedloopbuffer=10
buffer	"iohaltedloop" (please refer to section "6.1.11 Stand-Alone	
	Operation" for detailed information). It defines a maximum	set the buffer to a
	buffer size for the marking data. The buffer size should have a	maximum size of 100000
	size of 1/000000 at max. The minimum size depends on the	to data for about 1 cocond
	specific application, in fact, when it is set to some too small	marking time
	Values, drop-outs in marking operation may occur.	
	madified any longer. So any change on marking mode call the	
	similar (done e.g. by commands "ed cor" ("amoor")	
	will apply only to data which are not yet buffered. And as bigger	
	as this huffer is as longer it takes until the first new data after	
	change of any of these parameters can be emitted	
	This parameter requires firmware version 33 or newer	
autofile	Loads a special FPR stand-alone file from SD-card in some	autofile=0:/
	specific stand-alone modes. For a detailed description of possible	markdata.epr
	parameters, operation modes and usage please refer related	loads a file markdata.epr
	section below.	from disk; here 0:/ specifies
		the SD-card to be used.
		The .EPR-file itself can be
		generated within
		BeamConstruct out of a
		normal .BEAMP project
		file.
lobuff	Pre-loads one or more EPR files to the RAM of the controller to	iobuii=1
	allow faster switching in "loselect" or "idxselect" stand-alone	pre-load files 1 EPP and
	mode. This command can not be used to load file ULEPR	3 EPR on board start-up
minout	Configure a Digi I/O output pin to be used as "mark in progress"-	mipout=1
mpour	signal by default: here an output bit number in range 0.7 has to	use DOut1 for mark-in-
	be configured which will be set to HIGH as long as a marking	progress signal
	operation is in progress, the value given here can be overwritten	F 8 8
	by API-function E170X digi set mip output();	
	this parameter requires firmware version 30 or newer	
wetout	Configure a Digi I/O output pin to be used as "wait for external	wetout=0
	trigger"-signal by default; here an output bit number in range 07	use DOut0 for mark-in-
	has to be configured which will be set to HIGH as long as a	progress signal
	marking operation is in progress and the controller is waiting for	
	an external trigger signal to arrive at ExtStart input, the value	
	given here can be overwritten by API-function	
	E1/UX_digi_set_wet_output();	
	this parameter requires firmware version 30 or newer	
digiinit	Initialises the digital outputs on firmware start-up with the given	
	deraults. I his overrides the hardware defaults. I he default	and all other outputs to
	ugital values set here are NOT available on power up but a few	
	This function requires firmware version 32 or newer	

Parameter	Description	Example
digimask	Masks the digital inputs and specifies which inputs can be read.	digimask=253 use only Dln2 Dln7 as
	related value to 0, are no longer read. This may be useful for	input and ignore DIn0 and
	applications where encoder inputs are used together with a	DIn1
	IOSelect stand-alone operation and where the random state of	
	the encoder has to be masked out.	
digidebc	I his function requires firmware version 32 or newer.	digidebc=10
uigidebe	Digi IO extension board in order to not to let the inputs of the	set the debounce-time to
	noise or bouncing of mechanical inputs. The debouncing value is	310 usec
	given in time-units where every time-unit is equal to 31 usec. By	
lasausata	default 7 time-units are set.	lacorgato-2
lasergate	By default, the laser on/off information is provided via the	Use DOut3 to provide the
	parameter, a digital output of the Digi I/O extension board can be	laser gate signal
	specified, to provide the laser gate signal in parallel.	5 5
	Please refer to "6.4 E1701 Digi I/O Extension Board" for further	
	details about the digital interface.	
	This configuration parameter requires firmware version 41 or	
tunereadyo	In stand-alone modes, the ready-state of a loaded stand-alone	tunereadyout=1
ut	project is signalled via DOut0 by default (please refer to section	use LaserA to signal state
	"6.1.11.3 Stand-Alone Control" for further details). Using this	"ready" in stand-alone
	parameter, the used output can be changed. Here following	mode
	• 0 – DOut0 (default)	
	 1 – LaserA (has to be configured as GPO via the relate 	
	tune-flag)	
	• 2 – LaserB (has to be configured as GPO via the relate	
	tune-flag) This parameter requires firmware version 13 or newer	
tunemarko	In stand-alone modes, the ready-state of a loaded stand-alone	tunemarkout=2
ut	project is signalled via DOut1 by default (please refer to section	use LaserB to signal state
	"6.1.11.3 Stand-Alone Control" for further details). Using this	"ready" in stand-alone
	parameter, the used output can be changed. Here following	mode
	 • 0 - DOut1 (default) 	
	 1 – LaserA (has to be configured as GPO via the relate 	
	tune-flag)	
	• 2 – LaserB (has to be configured as GPO via the relate	
	tune-flag)	
tune	Enables special functions and features that are not activated by	tune=1
	default. As parameter a number can be handed over that	disables ExtStart input and
	specifies the functions to be enabled. Starting with firmware	switches over external
	version 41 the number can also be specified as hexadecimal	trigger function to DIn7
	value when it is prefixed with "UX". Following numbers can be concatenated by adding them:	Input
	1 (0x01) – use DIn7 of Digi I/O Extension Board as external	tune=0x1000
	trigger, this disables ExtStart input of E1701 Baseboard and LP8	force the acanner output
	Extension Board	to use XY2-100E mode
	2(0x02) - use additional marking encoder inputs on DIn2 and	
	DIn3 for 2D on-the-fly operations (requires firmware version 25	
	or newer)	
	4(0,04) anable storage of easier such as the last t	
	4 (UXU4) – enable storage of serial number count values to microSD card: this option is useful in case of stand-alone	
	operation mode when dynamic data with serial number counting	

[Parameter	Description	Example
		is used. When it is set, the current count value of all used serial	
		numbers is stored and reloaded on next power up. Thus their	
		values are not get lost when power was turned off. The values	
		are stored in a file with the same name like the "autofile" or the	
•		currently loaded .epr file but with extension ".ser".	
		ATTENTION: The file is saved on the FatFS formatted microSD	
		card. FatFS is NOT fault-proof, means it can be corrupted when	
		power is turned off during writing. So when this option is	
		enabled, user has to ensure power is NOT turned of while the	
		card writes to disk. Writing of serial number states is always	
		done in case they have changed, then it is started when state	
		LED of E1/01D board is switched off. while operation is mished	
		when this LED is turned back on the next time. So to ensure data	
		are written successionly, it is recommended to let this LED blink	
		automated environment this can be ensured by following	
		automated environment this can be ensured by following	
		1 stop all marking operations	
		2 ensure no new marking operation is triggered	
		3. wait for 2 seconds	
		4. turn power off	
		ATTENTION: due to this limitation it is not recommended to	
		work with this option but to save the state of the serial numbers	
		by sending ASCII command "cssta" instead (please refer below	
		for details)!	
		This value requires firmware version 12 or later.	
		8 (0x08) – invert LaserGate output to work as active HIGH	
		signal; when this option is set, logic of LaserGate-LED changes	
		too, it is on as long as laser is turned off and it is off as long as	
		laser is on (requires firmware version 16 or newer)	
		16(0x10) = invert aser A output to work as active HICH signal	
		(requires firmware version 16 or newer)	
		32 (0x20) – invert LaserB output to work as active HIGH signal	
		(requires firmware version 16 or newer)	
		64 (0x40) – use LaserA output as GPO (general purpose output	
		pin); when this flag is set, LaserA output is no longer able to emit	
		a frequency but can be used as digital output pin; when this value	
		is set, a tune-value of 16 (invert LaserA) is ignored. This flag has	
		to be set e.g. when LaserA has to be used together with	
		tunereadyout or tunemarkout parameter.	
		128 (0x80) – use LaserB output as GPO (general purpose output	
		pin); when this flag is set, LaserB output is no longer able to emit	
		a FPK pulse but can be used as digital output pin; when this value	
		is set, a tune-value of 32 (invert LaserB) is ignored. This flag has	
		to be set e.g. when LaserA has to be used together with	
		tunereauyout or tunemarkout parameter.	
		4096(0v1000) = operate in enhanced XV2-100 18 bit mode:	
		when this value is added to the type-parameter the controller	
		outputs more accurate 18 hit position data instead of the	
		standard 16 bit values in normal operation mode (requires	
		firmware version 24 or newer)	
		8192 (0x2000) – operate in XY3-100 mode; when this value is	

Parameter	Description	Example				
	added to the tune-parameter, the controller outputs more accurate position data instead of the standard 16 or 18 bit values in normal operation mode (requires firmware version 39 or newer)					
	32768 (0x8000) – invert the mark-in-progress signal (requires firmware version 32 or newer)					
	65536 (0x10000) – invert the wait-external-trigger signal (requires firmware version 32 or newer)					
	524288 (0x80000) – inverts the logic of the ExtStop input; by default, the stop-input is LOW and has to be set to HIGH in order to stop a running operation. When this flag is set, this is inverted, ExtStop has to kept HIGH for normal operation and a stop is performed as soon as it goes to LOW. This flag requires firmware version 41 or newer.					
	2097152 (0x200000) – halt the current marking operation when ExtStart input is at LOW; with this tune-flag set, the ExtStart input not only reacts on the rising edge to mark when waiting for an external trigger, it also requires to be HIGH in order to continue marking. So ExtStart acts as some kind of "enable" input. This flag requires firmware version 41 or newer.					
	4194304 (0x400000) – invert the LP8 signal of LP8 Extension (requires firmware version 41 or newer)					
	8388608 (0x800000) – invert the MO (main oscillator) signal of LP8 Extension (requires firmware version 41 or newer)					
	16777216 (0x1000000) – inverts the logic of the ExtStart input. By default, the start-input reacts on a rising edge. When this flag is set, this is inverted and a falling edge is expected to release an external trigger. This also has an effect on the behaviour of tune- flag 0x2000000, it is inverted too. This flag requires firmware version 41 or newer.					
sntp1	Allows to specify the IP of an SNTP time server. This option can be used in case of Ethernet usage to synchronise controller with an external time source. E1701D tries to connect to this server after initialisation of Ethernet interface and – if not successful – a few more times. These additional connection attempts are done whenever the state-LED is switched on. ATTENTION: when this function has to be used, the network or host-computer the controller is connected with needs to be able to route this request. This is a potentially dangerous operation because a connection between encapsulated machine network and open and dangerous Internet has to be established. Since this is NOT RECOMMENDED in general, this option should be used ONLY when it is 100% sure there is no possibility for people from outside to intrude the machine network! Instead of that it is recommended to set system time manually using host-computer and ASCII command "cstime" (please refer below). Alternatively it is also possible to contact an own, network-internal NTP- server	sntp1=83.170.1.42 - IP of time server at 3.de.pool.ntp.org is used for SNTP time retrieval (not recommended since this requires a connection to potentially dangerous Internet!)				
	When this option is used, the gateway and netmask have to be configured for the controllers Ethernet interface This parameter requires firmware version 12 or later.					

Parameter	Description	Example
sntp1offset	This value corresponds to sntp1 parameter above, it is used when system time is retrieved from an external time server to set an offset to the time returned from this server. The offset has to be specified in unit seconds. This parameter requires firmware version 12 or later.	sntploffset=-3600 - specifies an offset of minus one hour to the time returned from timeserver. So when the time server would return a current time of 11:42:17, the system time of the controller would be set to 10:42:17 with this value
gw1	Specifies a gateway-address for the scanner controllers Ethernet interface. This option belongs to parameter "ip1" and has to be set in case "sntp1" is used. This parameter requires firmware version 12 or later.	gw1=192.168.2.1 - use 192.168.2.1 as gateway
nm1	Specifies the netmask for the scanner controllers Ethernet interface. This option belongs to parameter "ip1" and has to be set in case "sntp1" is used. This parameter requires firmware version 12 or later.	nm1=255.255.255.0 - use upper 24 bits of current IP for netmask
usb	When this parameter is set to 0, USB interface is disabled completely. This means it is no longer possible to connect to E1701 USB serial interface via terminal software or via BeamConstruct and it is also no longer possible to retrieve BeamConstruct PRO license via USB. This option can be used to suppress illegal access to USB and saves some power. This parameter requires firmware 21 or newer.	usb=0 - turn off USB interface
eth	 This parameter specifies the behaviour of the Ethernet interface. Here following values can be set: O - Ethernet network interface is disabled completely. This means it is no longer possible to connect to E1701 via Telnet or via BeamConstruct. All SNTP-functionalities are disabled too. This option can be used to suppress illegal access to Ethernet, to save several seconds of startup-time and to save some power. 1 - this is the default mode which enables the Ethernet interface and checks once at the beginning if some Ethernet hardware is connected to the controller card; when the "eth"-parameter is not specified at all, the resulting behaviour is the same 2 - this enables Ethernet device only once during boot, in this mode the interface is polled regularly until an electrical connection is detected. As long as the controller is polling, the Alive-LED blinks very slow and toggles once in about 20 seconds, when an Ethernet device was detected, the blink frequency changes to normal speed; PLEASE NOTE: when this mode is used, access via USB is limited, so "eth" should be set to "2" only when no communication via USB is intended. The "eth"-value of 2 requires a firmware version 39 or newer 	eth=0 - turn off Ethernet interface completely
pethd	When Ethernet connection is used, it has to be established on power-up of the controller card as this connection is set-up and configured by the controller only once during boot. There may be situations where the other side of the Ethernet connection can not boot up as fast as E1701. In such cases this parameter can be used. It delays initialisation of Ethernet by the time given as parameter. The time is specified in unit "delayticks" where one	pethd=20 - halt initialisation of the controller for about 10 seconds prior to initialisation of Ethernet interface

Parameter	Description	Example
	"delaytick" is equal to about 0,5 seconds.	
	As long as the controller is halted during initialisation due to this	
	parameter, this is signalled by the Stop-LED (please refer to 6.1.5	
	User LEDs for details).	
	This feature requires a firmware version 34 or newer.	
cswaf	Sets a factor in unit bits per mm that is used with all commands	cswaf=671089 - set the
	that specify some distance or position (such as cspof). When this	conversion factor from bits
	factor is set to a proper value, the given positions/distances can	to mm for a 100x100 mm
	be specified in unit um instead of bits.	working area
	This parameter requires a firmware version 45 or newer.	

6.1.8.1 Firmware Update

As described above the firmware is located on microSD-Card and therefore can be updated easily:

- 1. remove the microSD-Card as described above
- 2. download a new firmware from <u>https://halaser.systems/download/Firmware/E1701</u> (the higher the number in the file name, the newer the firmware is)
- 3. copy the contents of this ZIP-file to microSD-Card (please take care about e1701.cfg in case it contains a changed configuration)
- 4. reinsert microSD-Card as described in previous section

6.1.9 Laser/Scanner Signals

The white 26 pin connector provides several signals to be used to control up to three galvos of a scanhead and a laser source. It can be connected to an XY2-100 or XY2-100-E compatible scanner system via an adapter cable which splits XY2-100 and laser/input control signals. The connector is a white one to avoid confusion when a LP8 Extension Board is used too. The connector provides following signals:

Upper Row Of Pins	Signal	Voltage	Remarks	Lower Row Of Pins	Signal	Voltage	Remarks
1	CLK-		XY2-100-/	2	CLK+		XY2-100-/
3	SYNC-		XY2-100-E-	4	SYNC+		ХҮ2-100-Е-
5	Х-		compatible	6	X+		compatible
7	Y-		signals	8	Y+		signals
9	Z-			10	Z+		
11	LaserA	CMOS, 0/5V, max 14 mA	Laser control signals	12	GND	GND	
13	Laser Gate	CMOS, 0/5V, max 14 mA		14	GND	GND	
15	LaserB	CMOS, 0/5V, max 14 mA		16	ExtStart	CMOS, 0/5V	Input control signals
17	5V	5V		18	ExtStop	CMOS, 0/5V	
19			do not connect	20	GND	GND	
21	GND	GND		22	GND	GND	
23			do not	24			do not
			connect				connect
25			do not	26			do not
			connect				connect

Laser Gate provides laser modulation signal, turns on the laser during marks and off during jumps.

LaserA usage depends on software configuration and control, it is able to output a pulse-width modulated frequency (e.g. for controlling CO₂ lasers), CW/continuously running frequency (e.g. for fiber lasers) or Q-Switch signal (e.g. for YAG lasers) in range 25 Hz..20 MHz.

LaserB can be used for emitting a FPK pulse (e.g. for YAG lasers).

ExtStart expects a CMOS-level input signal in respect to GND and can be used as external trigger signal to start operations when a HIGH-signal is detected at input pin.

ExtStop expects a CMOS-level input signal in respect to GND and can be used as external stop-signal in order to stop a running marking operation by using a HIGH-signal at input pin.

The E1701D can operate in XY3-100 mode too. This requires a firmware version 37 or newer. The controller can be connected to an XY3-100 compatible scanner system via an adapter cable which splits XY3-100 and laser/input control signals. The scanner connector is a white one to avoid confusion when a LP8 Extension Board is used too. The connector provides following signals:

Upper Row Of Pins	Signal	Voltage	Remarks	Lower Row Of Pins	Signal	Voltage	Remarks
1	A-		XY3-100-	2	A+		XY3-100-
3	B-		compatible	4	B+		compatible
5	C-		signals	6	C+		signals
7	D-			8	D+		
9				10			
11	LaserA	CMOS, 0/5V, max 14 mA	Laser control signals	12	GND	GND	
13	Laser Gate	CMOS, 0/5V, max 14 mA		14	GND	GND	
15	LaserB	CMOS, 0/5V, max 14 mA		16	ExtStart	CMOS, 0/5V	Input control signals
17	5V	5V		18	ExtStop	CMOS, 0/5V	
19			do not connect	20	GND	GND	
21	GND	GND		22	GND	GND	
23			do not	24			do not connect
25	F-		XY3-100 backchannel ¹⁾	26	F+		XY3-100 backchannel ¹⁾

¹⁾ Requires hardware revision 1.5 or newer

Laser Gate provides laser modulation signal, turns on the laser during marks and off during jumps.

LaserA usage depends on software configuration and control, it is able to output a pulse-width modulated frequency (e.g. for controlling CO₂ lasers), CW/continuously running frequency (e.g. for fiber lasers) or Q-Switch signal (e.g. for YAG lasers) in range 25 Hz..20 MHz.

LaserB can be used for emitting a FPK pulse (e.g. for YAG lasers).

ExtStart expects a CMOS-level input signal in respect to GND and can be used as external trigger signal to start operations when a HIGH-signal is detected at input pin.

ExtStop expects a CMOS-level input signal in respect to GND and can be used as external stop-signal in order to stop a running marking operation by using a HIGH-signal at input pin.

6.1.9.1 XY2-100 Connection Cable

E1701D scanner controller board can operate an XY2-100-compatible scanner system directly. Here an adapter-cable is required that splits XY2-100 signals and additional laser/input control signals. Using such a cable white 26 pin connector described above should be converted to a female, XY2-100-compatible, 25 pin SUB-D connector (to connect with scanhead) and a female 9 pin SUB-D connector (which provides laser signals and start/stop inputs).

Pinout of a D-SUB25 XY2-100 connector should be conform to standard with ground-signals (GND) at pins 11, 23 and 24:



XY2-100 status signals from scanhead are not used for E1701D.

Pinout of a limited D-SUB15 XY2-100 connector depends on used scanhead but typically looks like this:



XY2-100 status signals from scanhead are not used for E1701D.

Possible pinout of 9 pin SUB-D laser signal and control connector is shown below:



Please note: to avoid this complex and potentially error-prone wiring, you also can use the E1701dock for simple and easy 1:1 connection using a standard cable. For details please refer to section "6.6 E1701dock Extension Board".

6.1.9.2 XY3-100 Connection Cable

E1701D scanner controller board can operate an XY3-100-compatible scanner system directly. Here an adapter-cable is required that splits XY3-100 signals and additional laser/input control signals. Using such a cable white 26 pin connector described above should be converted to a female, XY3-100-compatible, 25 pin SUB-D connector (to connect with scanhead) and a female 9 pin SUB-D connector (which provides laser signals and start/stop inputs).

Pinout of a D-SUB25 XY3-100 connector should be conform to standard with ground-signals (GND) at pins 11, 23 and 24:



XY3-100 E+- signals are not used for E1701D.

Possible pinout of 9 pin SUB-D laser signal and control connector is shown below:



Please note: to avoid this complex and potentially error-prone wiring, you also can use the E1701dock for simple and easy 1:1 connection using a standard cable. For details please refer to section "6.6 E1701dock Extension Board".

6.1.10 Extension Connectors

The two extension connectors on each side of the board can be used to place extension boards with additional peripheral interfaces. The extension connectors are designed to place/remove boards from time to time but they are not intended for constant hardware changes. So changing extension boards repeatedly and often e.g. as permanent part of a production process is not recommended.



Key pin closed on lower connector and missing in upper board to ensure correct orientation

PLEASE NOTE: when placing a new extension board 1.check correct orientation and position of the key pin which is closed in connector 2.place the pins of the extension boards onto the extension connectors exactly 3.move down the extension board by pressing on its extension connectors gently; DO NOT PRESS THE BOARD ITSELF BUT ONLY THE CONNECTORS!



PLEASE NOTE: When removing an extension board DO NOT pull on the extension connectors but hold both boards on their long side directly at the PCBs edges:



Due to of the large number of pins, it is easy to plug in an extension but more difficult to pull it out. So when removing an extension board, it is recommended to be very slow and to carefully pull each side up just a little bit to avoid bending of the pins as they exit.

6.1.11 Stand-Alone Operation

E1701 scanner controller cards can be operated in stand-alone mode. In this mode all marking data are stored on SD-card and the board can operate without direct control of a host-PC that sends the data to be marked. Such stand-alone marking data can be created e.g. in BeamConstruct marking software.

The names of these stand-alone files have to be in format 8.3, means the filename has to consist of eight characters at max, followed by a file extension which consists of 3 characters. The base-stand-alone file comes with a file-extension .EPR. In case the stand-alone file contains dynamic data, a second file with the same filename but the extension .DAT is created (for details about dynamic stand-alone data please refer to section "6.1.11.1 Create Stand-Alone Data with BeamConstruct"). When a stand-alone-mode of type "ioselect" is used, the filename has to follow some specific rules too, here it typically has to be a number which corresponds to the selection done at the digital inputs (for details about the different stand-alone modes and their behaviour please refer to section "6.1.11.2 Stand-Alone Configuration Parameters").

6.1.11.1 Create Stand-Alone Data with BeamConstruct

To use BeamConstruct for generation of stand-alone data for E1701 scanner controllers, the card has to be fully configured (including all scanner, laser and pen-parameters). Next the marking data to be stored on SD-card have to be created. To generate stand-alone data, menu "Processing", sub-menu "Write Marking Data to File" or "Send Named Marking Data" has to be selected.

First one gives the possibility to write the data to microSD card when E1701 is switched off and the microSD card is plugged into host PC. Here it is recommended to use file extension ".EPR" for the file generated by BeamConstruct. Next it is also recommended to always let BeamConstruct write to microSD card directly because sometimes more than only one file is created. Direct write operation to BeamConstruct ensures all files are available on microSD and no data can be forgotten to be copied.

The second variant allows to download the stand-alone data to the controller while it is connected and running. Precondition for sending data to a running controller are:

- no mark operation is in progress (controller is idle)
- no stand-alone project is loaded (please refer to description of ioselect-mode and stand-alone control commands below).
- a valid name is given in style 0:/filename.epr

This operation creates the .EPR-file and all additional files on microSD card of the running controller automatically.

PLEASE NOTE: such an .EPR-stand-alone file can NOT be converted back to vector data that could be edited in BeamConstruct! Creating these files is a one-way-conversion of your projects. Thus it is recommended to save these projects twice – once as normal .BEAMP-File which can be loaded and modified later and once as .EPR-file which has to be used on SD-card. This also means such .EPR-files are protected so that it is possible to give away designs to some end-users which shall not be able to modify them.

E1701 controller supports all static data in stand-alone mode (like all kinds of static geometries, output signals, waiting for input commands, waiting for trigger, all laser- and scanner parameters). But it does not store the vector data using a possibly configured correction table! To get a valid correction for stand-alone operations, the related correction file has to be saved on microSD card and needs to be activated using parameter "corrtable0" in e1701.cfg configuration file (please refer to description above).

Next E1701 scanner card supports dynamic content when following conditions are met:

- a text element uses one of the laser vector font families "Roman", "Script" or "Times" and it makes use of an input element or
- a text element makes use of a TrueType font <u>and</u> it makes use of an input element; here any available TrueType font can be used and several hatch-patterns can be applied

 \rightarrow for both types of text some limitations apply (only left to right orientation, no

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newer is required, BeamConstruct version 4.8 or newer is required); or																								

- a barcode element uses type "DataMatrix" with option "MergeCells" disabled <u>and</u> it makes use of an input element
- any kind of hatch and combined hatches can be applied to a barcode element (but not to a text element)
- marking output is neither XY-flipped nor mirrored nor rotated or slanted
- when an input element of type "Serial Number" is used, serial number counting is done according to the settings of the related element
- when an input element of type "CSV File Data" is used, elements out of a CSV-table can be read and used for the dynamic element:

the CSV-file itself needs to be placed on the SD-card and has to use the same name like the EPR file but with extension CSV (so when the stand-alone file is named "data.epr", the CSV-file needs to be named "data.csv"), resulting from that one EPR file can handle exactly one CSV file; supported parameters of the CSV input element are the column separator, the data column to read the data from and the "Endless loop" option (for details please refer to the manual of BeamConstruct);

this feature requires a firmware version 40 or newer

• when any input element is used, the contents of the text/barcode can be changed via command "cstxt", in this case the automatic updating of the input element has no effect

When these conditions are met, a text or barcode can be modified during stand-alone operation either via stand-alone control commands as described below or via a Serial Number input element that is applied to it in BeamConstruct. Here all serial number, time, date and formatting functions of this input element are supported. To get a valid time in stand-alone mode, it needs to be set after boot-up via stand-alone control

commands (as described below) or a SNTP time server has to be configured to retrieve current time from an external source (please refer to description e1701.cfg parameters above).

6.1.11.2 Stand-Alone Configuration Parameters

Within e1701.cfg configuration file of E1701 scanner controller one of the following stand-alone operation modes can be selected via the configuration parameter "standalone":

standalone=off

Stand-alone mode is fully disabled, the card acts as normal, host-PC-controlled device and all .epr-files on the SD-card are ignored. Digital outputs are not toggled since no stand-alone operational states have to be signalised here (please refer next section).

standalone=auto

Stand-alone mode is enabled, a file specified by and additional parameter "autofile" is loaded and prepared for marking. Marking of this file is started only when an external trigger signal is detected. The file itself has to be specified via additional configuration parameter that gives the filename of the stand-alone file to be loaded. As an example a parameter: "autofile=0:/myfile.epr" would try to load the file "myfile.epr" from SD-card and prepare it for marking. In this mode the digital outputs are toggled as described in next section.

standalone=loop

This is the same like mode "auto" described above, but using "loop" the E1701 controller does NOT wait for an external trigger signal! So when no trigger points are set in stand-alone datafile itself, in this mode marking would be done in an infinite loop, repeating the given "autofile" again and again.

standalone=haltedloop

This is the same like mode "loop" described above, but marking does not start immediately. By default the controller is in state "halt" until the ExtStart input is set to HIGH level. Marking continues only as long this input stays at HIGH. When it goes back to LOW, marking is continued until the laser is turned off the next time (defined by the geometry which is currently loaded) and it is halted again. Next time ExtStart goes to HIGH, marking continues at the position where it was halted before.

Please note: for this mode it is recommended to have marking data with vectors that are interrupted by jumps from time to time. When ExtStart gows to LOW, marking continues until the next jump is found. This means, when the controller processes a complex, long-lasting vector, marking will continue for the whole time this vector needs although ExtStart is already wt LOW. So the laser is never interrupted and turned off within a mark operation.

This mode requires firmware version 27 or newer.

In this mode the timeout-parameter "haltedlooptimeout" is used.

standalone=iohaltedloop

This mode is a combination out of "haltedloop" described above and "ioselect" described below (please refer there for usage details). In this mode a project can be selected via digital inputs but it is started immediately and marked in an endless loop as long as ExtStart input is HIGH (so the level at ExtStart is checked, not the rising edge of an applied signal). When a different project is selected by applying a different input pattern at DIn digital inputs, the current project is cancelled and the new one is started in a loop again. This mode requires firmware version 28 or newer.

In this mode the timeout-parameter "haltedlooptimeout" is used.

standalone=ioselect

This mode requires Digi I/O Extension Board (please refer below). Here it is possible to select one of 256 standalone marking jobs via the digital inputs. The number that results out of the input pattern of the Digi I/O input lines specifies the filename of the marking job that has to be loaded from SD card:

Selected input(s)	Stand-alone file loaded from SD-card							
All inputs set to LOW (not recommended to be used)	0.epr							
DIn0 set to HIGH	1.epr							
DIn1 set to HIGH	2.epr							
DIn0 and DIn1 set to HIGH	3.epr							
DIn2 set to HIGH	4.epr							
DIn0 and DIn2 set to HIGH	5.epr							
DIn1 and DIn2 set to HIGH	6.epr							
DIn0, DIn1 and DIn2 set to HIGH	7.epr							
DIn3 set to HIGH	8.epr							
DIn4 set to HIGH	16.epr							
DIn5 set to HIGH	32.epr							
DIn6 set to HIGH	64.epr							
DIn7 set to HIGH	128.epr							
All inputs set to high	255.epr							

PLEASE NOTE: 0.epr (no inputs set to HIGH) can be used but it is not recommended to do that. This value should be reserved for "no job active" to set the card into an inactive mode also in stand-alone operational mode. This may be necessary e.g. when new project data are downloaded to the controller without removing the SD-card.

Marking of a IO-selected job is started by external trigger signal (ExtStart input). When the input pattern at DInO..DIn7 changes during marking, the currently running operation is continued and the other stand-alone job is loaded after marking operation has finished. In this mode the digital outputs are toggled as described in next section.

In stand-alone mode "ioselect" and "idxselect". EPR-files are loaded from microSD card as soon as a new input pattern is detected at digital inputs or as soon as a new index is loaded by command "clepr". Depending on the size of the .EPR file and the speed of the microSD card, this may take a time that is too long for high-speed applications. Thus it is possible to operate such projects from controller's RAM completely: in e1701.cfg the numbers of the files to be loaded have to be specified with parameter "iobuff", it can be used up to 20 times and expects the number of the file (so a line "iobuff=3" would be responsible for preloading file "0:/3.epr"), file "0.epr" can not be loaded by this command.

Now these files are loaded into RAM and switching from one to an other is done much faster since toggling between them is done controller-internal and no more disk-operations are necessary for that. PLEASE NOTE: when too much too large .EPR files are selected for preloading, this may exceed the available memory on card. This is signalled by the Error LED turned on and an appropriate message is stored in log buffer. In such a case a proper operation is no longer guaranteed.

The prebuffer-feature requires firmware version 27 or newer.

```
standalone=idxselect
```

This mode works exactly like the mode "ioselect" (described above), but it does not need the Digi I/O Extension board. Instead of that, loading of a file can be done via an index number and the command clepr. There the

number of the file to be loaded has to be given. For a full description of all functions and features of mode "idxselect", please refer the "ioselect" description above. This stand-alone mode requires a firmware version 35 or newer.

iolatch=1

This option can be enabled for one of the digital-input-controlled stand-alone modes "ioselect", "idxselect" and "iohaltedloop". When this option is set to 0 or when it does not exist in e1701.cfg, the digital input bitpattern at DIn0..DIn7 is used as new input value as soon as it is detected. When it is enabled, DIn7 is used as latch-bit. Then the digital input bitpattern at DIn0..DIn6 is used only when DIn7 is set to HIGH. So a proper method of selecting a digital input bitpattern with latch enabled would be:

- ensure DIn7 is at LOW
- apply the desired bitpattern at DIn0..DIn6
- wait for the maximum time the input bits may need to settle (depends on the external hardware and its capabilities)
- set DIn7 to HIGH
- wait until DOut0 goes to LOW
- wait until DOutO goes back to HIGH (when a valid bitpattern was applied that corresponds to an
 existing EPR file) or until loading timeout has elapsed (when a bitpattern has been applied where no
 EPR file exists for
- set DIn7 to LOW

So as long as DIn7 is at low, state-changes at DIn0..DIn6 are ignored and the last detected bitpattern is used. In this mode only 127 different input bitpatterns are possible as DIn7 is used as latch bit. This function is available in firmware versions 38 or newer.

6.1.11.3 Stand-Alone Control

The current stand-alone operational state is signalised via digital outputs (requires Digi I/O Extension Board):

DOut0 - ready for marking - this output goes to HIGH as soon as a stand-alone job could be found on disk, was loaded successfully and is ready for marking. So external start signal should not be given until this output is HIGH. When a new stand-alone file is selected (e.g. via digital inputs in "ioselect"-mode) this output goes to LOW. It is switched back to HIGH only when the new file could be loaded successfully too.

This signal can be mapped to a different hardware output using configuration parameter tunereadyout and the related tune-flag.

DOut1 – marking active – as long as this output is HIGH, a marking operation is in progress. When a different stand-alone file is selected (e.g. via digital inputs) as long as this output is HIGH, marking is continued and the new file is NOT loaded. Once the current marking operation is completed, the output goes to LOW. After that the board continues with current marking data (when no new ones have been selected), or it tries to load new ones (when a new file was selected).

Please note: in firmware versions prior to v32 in stand-alone modes "haltedloop" and "iohaltedloop" this signal is not used since the user had full control over the marking process via the ExtStart input. So in case of these modes the logic is: when both, DOut0 and ExtStart are at HIGH, the controller is marking. Starting with firmware version 31 the DOut1 signal is used in same way as for all other stand-alone modes.

This signal can be mapped to a different hardware output using configuration parameter tunemarkout and the related tune-flag.

6.2 E1701A Analogue Laser Scanner Controller Baseboard



The E1701A Analogue Laser Scanner Controller Baseboard provides following connectors and interfaces:

- 1. Ethernet for communication with the host system, marking information are submitted via this path
- 2. USB via microUSB connector for providing BeamConstruct PRO license to host system and optionally for submitting marking data from host to E1701A card (in case Ethernet is not used)
- 3. Power connect with power supply +- 15V DC
- 4. Power LED lights when power is available
- 5. User LEDs show operational and error states of card
- 6. Laser LED shows modulation state of laser
- 7. microSD-card (on bottom side) storage place for firmware and extended configuration file, can be used to upgrade firmware, to change the card's IP and other things more
- 8. Laser/Scanner signals <u>white</u> 26 pin laser and scanner output connector which provides analogue scanner signals as well as laser and marking control IOs
- 9. Extension connectors extension boards can be placed below of E1701A Baseboard in order to add some more functionality and hardware interfaces to the board
- 10. DAC heatsinks

6.2.1 Ethernet

For a description of usage and configuration of Ethernet interface please refer to related section about E1701D's Ethernet interface above.

6.2.2 USB

This is a standard miniUSB-connector for connection of the board with the host system. It is used to retrieve BeamConstruct PRO license and optionally to send marking data to the card. When USB is used for sending all scanner and laser data, Ethernet cable does not need to be connected.



PLEASE NOTE: USB 2.0 is much slower than a standard 100 Mbit Ethernet connection, so expect slower execution in case of complex marking data!

Required device driver is installed together with installation of the HALsetup software package (Windows) or comes with operating system by default (Linux). E1701A card appears as COM-interface on Windows using any free number for the port. With Linux it appears as /dev/ttyACMx where "x" is any number. These numbers are provided by the operating system automatically.



PLEASE NOTE: this connection <u>can not</u> be used to power E1701A scanner controller. It may boot up and react on control commands from host PC but it will not emit any signals at analogue output connectors! A separate power supply via +-15V is mandatory in order to operate E1701A controller. For details about this power supply please refer to following section.

6.2.3 Power

Power supply for E1701A scanner controller board is done via 6 pin header on upper left corner of the board. Here pairs of pins belong to same power level. An appropriate fuse for circuit protection must be provided by the external equipment:



Power has to be supplied via this connector by connecting to a bipolar power supply with a maximum voltage of +-15V DC, max +/- 0.15V tolerance and 1.5A (stabilised and smoothed). Do not apply voltages in excess of 15V or with inverted polarity to this input. The DC power supply must be grounded.

To avoid the boards components heat up more than necessary, the power input can be limited:

- when XY outputs operate with +-5V, voltage of +-8V is enough for proper operation
 - when XY outputs operate with +-10V, voltage of +-13V is enough for proper operation

Operating E1701A with a lower voltage than the maximum of +-15V can not only help to keep the board cooler but also saves power during operation.

To avoid high frequency interferences from other electrical equipment or from within the power supply, it is recommended to place a ferrite bead at the cable close to the board. Please also check for correct shielding in respect to the equipment the E1701A card is used within.

When there is no single power supply available which provides +-15V outputs, two separate 15V power supplies can be used too:



Positive output of the first power supply and negative output of the second one need to be connected with each other and form the centre ground connector. The remaining negative output of the first and positive output of the second power supply then are the -V and +V output.

6.2.4 Power LED

For a description of Power LED please refer to related section in description of E1701D controller above.

6.2.5 User LEDs

For a description of User LEDs please refer to related section in description of E1701D controller above.
6.2.6 Laser LED

For a description of Laser LEDs please refer to related section in description of E1701D controller above.

6.2.7 microSD-Card

For a description of microSD card, its usage, configuration possibilities, firmware updates and others please refer to related section in description of E1701D controller above.

6.2.8 Laser/Scanner Signals

The white 26 pin connector provides several signals to be used to control two galvos of a scanhead and a laser source. The connector is a white one to avoid confusion when a LP8 Extension Board is used too. The connector provides following signals:

Upper Row Of	Signal	Voltage	Remarks	Lower Row Of	Signal	Voltage	Remarks
Pins				Pins			
1	X+	+-5V / +-10V,		2	X-	+-5V / +-10V,	
		max 5 mA				max 5 mA	
3	Y+	+-5V / +-10V,		4	Y-	+-5V / +-10V,	
		max 5 mA				max 5 mA	
5	AOut1	05V, max 10 mA		6	GND _{AOut1}	GND	
7	Static		Connected	8	Static		Connected
	Interlock		with pin 8		Interlock		with pin 7
9	AOut1	05V, max 10		10	GND _{AOut1}	GND	
		mA					
11	AOut2	05V, max 10		12	GND _{AOut2}	GND	
		mA					
13	AOut3	05V, max 10		14	GND _{AOut3}	GND	
		mA					
15	LaserGate	CMOS, 0/5V,		16	GND	GND	
		max 14 mA					
17			do not	18	ExtStart	CMOS, 0/5V	Input
10	5) (5) (connect	00	E. I.C.		
19	5V	5V		20	ExtStop	CMOS, 0/5V	Input
21			donot	22			do not
			connect				connect
23			do not	24	GND	GND	
05			connect				
25	LaserGate	CMOS, 0/5V,		26			donot
		max 14 mA					connect

LaserGate provides laser modulation signal, turns on the laser during marks and off during jumps. Outputs LaserGate at pin 15 and LaserGate at pin 25 are working fully parallel, so the maximum current that can be pulled out of <u>both together</u> is 14 mA.

Analogue outputs AOut1..AOut3 provide additional analogue control. Outputs AOut1 at pin 5 and AOut1 at pin 9 are working fully parallel, so the maximum current that can be pulled out of <u>both together</u> is 10 mA.

ExtStart expects a CMOS-level input signal in respect to GND and can be used as external trigger signal to start operations when a HIGH-signal is detected at input pin.

ExtStop expects a CMOS-level input signal in respect to GND and can be used as external stop-signal in order to stop a running marking operation by using a HIGH-signal at input pin.

Static Interlock at pins 7 and 8 is available to be compatible with ILDA standard.

PLEASE NOTE: these outputs are connected statically to each other, means there is no condition where connection between pin 7 and 8 is interrupted! Thus this connection can not be used for security locks in order to turn off the laser. Here additional, external security measures are necessary!

6.2.9 Extension Connectors

The two extension connectors on each side of the board can be used to place extension boards with additional peripheral interfaces between E1701A Baseboard and its underlying processor board. So comparing to extensions added to E1701D scanner controller (as described in detail above), E1701A baseboard always has to be placed on top. Thus for extending E1701A the baseboard has to be separated from its processor board (as described in detail in related section in E1701D description above), then extension board(s) has/have to be placed on processor board while E1701A baseboard afterwards has to complete this set and needs to be added on top.

For a more detailed description about how to unmount and mount the boards in order to add extensions, please refer to related section in E1701D description above

PLEASE NOTE: when placing a new extension board or when adding E1701A board on top: 1.check correct orientation and position of the key pin which is closed in connector 2.place the pins of the extension boards onto the extension connectors exactly 3.move down the extension board by pressing on its extension connectors gently; DO NOT PRESS THE BOARD ITSELF BUT ONLY THE CONNECTORS!

6.2.10 DAC Heatsinks

The DAC heatsinks at the output lines of E1701A can become quite hot. Normal operation temperature can be up to 125°C without any damage to the electronics. But for integration of this board it is important to ensure

a) proper air flow and

b) nobody and nothing touches these heatsinks in order to avoid injury or other hardware to be damaged. To limit temperature at these heatsinks, please refer to section regarding power supply of E1701A above.

6.2.11 Stand-Alone Operation

For a description of Stand-Alone-Operation, it possibilities, usage and configuration please refer to related section in description of E1701D controller above.

6.3 E1701 LP8 Extension Board

The E1701 LP8 Extension Board can be used with E1701D and E1701A baseboards and provides following features:



- 1. MO LED shows state of Main Oscillator output
- 2. Laser signals <u>black</u> 26 pin laser output connector which provides signals for controlling a laser
- 3. Extension connectors more extension boards can be placed here in order to add some more functionality and hardware interfaces to the board, please refer to related section in description of baseboard above

6.3.1 MO LED

This LED is specific to the Main Oscillator output signal described below. As long as the signal is on (HIGH-signal at output pin), the LED is turned on.

6.3.2 Laser Signals

The black 26 pin connector provides several signals for controlling a laser source. It can be used e.g. together with YAG, CO₂, IPG[™], fiber and compatible lasers since it provides additional signals and frequencies these laser types may require for proper operation. To avoid confusion with similar connector used on E1701D Base board this connector is black.

The connector provides following signals:

Upper Row Of Pins	Signal	Voltage	Remarks	Lower Row Of Pins	Signal	Voltage	Remarks
1	LP8_0	CMOS, 0/5V, max 8 mA		2	GND	GND	
3	LP8_1	CMOS, 0/5V, max 8 mA		4			
5	LP8_2	CMOS, 0/5V, max 8 mA		6	5V	5V	
7	LP8_3	CMOS, 0/5V, max 8 mA		8	МО	CMOS, 0/5V, max 8 mA	Main Oscillator
9	LP8_4	CMOS, 0/5V, max 8 mA		10	AOut0	05V, max 15 mA	Analogue output
11	LP8_5	CMOS, 0/5V, max 8 mA		12			
13	LP8_6	CMOS, 0/5V, max 8 mA		14			
15	LP8_7	CMOS, 0/5V, max 8 mA		16			
17	LP8 Latch	CMOS, 0/5V, max 8 mA		18	5V	5V	
19	LaserB	CMOS, 0/5V, max 14 mA	FPK	20			Connected to pin 21
21			Connected to pin 20	22	LaserA	CMOS, 0/5V, max 14 mA	PWM, frequency or Q- Switch
23	GND	GND		24			
25	5V	5V		26	Laser Gate ¹	CMOS, 0/5V, max 14 mA	

LP8_0...LP8_7 provide parallel 8 bit output signal (e.g. for power control with IPG(tm)/fiber lasers, waveform selection for SPI(tm) lasers and other).

LP8 Latch pin signals valid output at LP8_0..LP8_7 and AOut0 by submitting a latch pulse of software-controlled length.

MO can be used to enable main oscillator (e.g. for IPG(tm)/fiber lasers or compatible).

LaserA usage depends on software configuration and control, it is able to output a pulse-width modulated frequency (e.g. for controlling CO₂ lasers), CW/continuously running frequency (e.g. for fiber lasers) or Q-Switch signal (e.g. for YAG lasers) in range 25 Hz..20 MHz.

LaserB can be used for emitting a FPK pulse (e.g. for YAG lasers).

AOut0 pin provides unipolar analogue output for controlling e.g. laser power or additional equipment. This output is directly dependent on LP8_0..LP8_7 output, they are electrically connected and therefore can't have different values and can't be controlled by software independently. So when LP8 outputs are all LOW, AOut0 is on 0V. When LP8 outputs are all HIGH, AOut0 is 5V.

PLEASE NOTE: output of 5V at AOut0 depends on the used power supply. So in case board is powered via USB and USB power supply delivers less than 5V, maximum output on AOut0 will be less than 5V too. Here is would be recommended to use the base board with an external power supply that feeds exactly 5V into it.

6.3.3 Extension Connectors

The two extension connectors on each side of the board can be used to place extension boards with additional peripheral interfaces. For a description of handling and usage of these connectors please refer above.

¹ requires hardware-revision 1.1 or newer

6.4 E1701 Digi I/O Extension Board

The E1701 Digi I/O Extension Board can be used with E1701D and E1701A baseboards and provides following features:



- 1. Digi I/O electrically insulated digital in- and outputs
- 2. optional inputs for 90 degree phase shifted encoders to be used with marking on-the-fly operations
- 3. Opto-Configuration choose operation mode for Digi I/Os
- 4. Input state LEDs displaying of HIGH/LOW state of used inputs

In case more extension boards are used on E1701D, Digi I/O extension always has to be placed on top. For E1701A a specific variant of the Digi I/O extension has to be used which can be stacked and placed below of the E1701A baseboard which always needs to stay on top.

6.4.1 Digi I/O

The 20 pin connector provides 8 lines for input and 8 lines for output of digital signals that can work on CMOS level (non-insulated mode) or via opto-couplers (electrically insulated mode with external power supply) optionally. The operation mode depends on jumper settings described below. The connector is used as follows:

Upper Row Of Pins	Signal	Voltage	Remarks	Lower Row Of Pins	Signal	Voltage	Remarks
1	V _{ext}	524V	Input voltage to be used in opto- insulated mode only	2	GND _{ext}	GND	External ground
3	DOut0	CMOS, 0/5V or 0/V _{ext}	Default level: LOW ¹⁾	4	DIn0	CMOS, 0/5V or 0/V _{ext}	Encoder-input A1 for marking on- the-fly
5	DOut1	CMOS, 0/5V or 0/V _{ext}	Default level: LOW ¹⁾	6	Dln1	CMOS, 0/5V or 0/V _{ext}	Encoder-input B1 for marking on- the-fly
7	DOut2	CMOS, 0/5V or 0/V _{ext}	Default level: LOW ¹⁾	8	DIn2	CMOS, 0/5V or 0/V _{ext}	Second encoder- input A2 for marking on-the- fly
9	DOut3	CMOS, 0/5V or 0/V _{ext}	Default level: LOW ¹⁾	10	DIn3	CMOS, 0/5V or 0/V _{ext}	Second encoder- input B2 for marking on-the- fly
11	DOut4	CMOS, 0/5V or 0/V _{ext}	Default level: HIGH ¹⁾	12	DIn4	CMOS, 0/5V or 0/V _{ext}	
13	DOut5	CMOS, 0/5V or 0/V _{ext}	Default level: HIGH ¹⁾	14	DIn5	CMOS, 0/5V or 0/V _{ext}	
15	DOut6	CMOS, 0/5V or 0/V _{ext}	Default level: HIGH ¹⁾	16	DIn6	CMOS, 0/5V or 0/V _{ext}	
17	DOut7	CMOS, 0/5V or 0/V _{ext}	Default level: HIGH ¹⁾	18	DIn7	CMOS, 0/5V or 0/V _{ext}	
19	V	5V	Board voltage, to be used only when not operating in insulated mode	20	GND	GND	Board-internal ground

¹⁾ Please note the wiring scheme and the resulting, inverted logic below: a level of LOW means, the output is pulled to GND and a load that is connected from V to this pin is turned on. An level of HIGH means, the output is pulled to V and a properly wired load if turned off.

 V_{ext} and GND_{ext} depend on opto-configuration as described below. In opto-insulated mode (opto-configuration jumpers not set) external power supply has to be connected to these inputs. Then DIn0..DIn7 and DOut0..DOut7 work in respect to this external power.

WARNING: When no opto-insulated mode is selected (opto-configuration jumpers are set), do NOT FEED ANY POWER into V_{ext} , this would cause damage to the E1701 board! In this case V_{ext} is equal to V (5V) of the board and GND_{ext} is connected to boards ground GND.

Maximum current for every output is 15 mA when internally powered (non-insulated mode), here it is recommended to use an external power supply.

Maximum current for outputs DOut0..DOut3 is 50 mA when externally powered (V_{ext} in insulated mode). Signal output lines DOut0..DOut7 operate in open collector mode and have to be wired as follows:



Here "DOutx" symbolises one of the digital outputs DOut0..DOut7. V+ is either V (5V internal, non-insulated mode) or V_{ext} (up to 24V external, insulated mode). GND is either GND (non-insulated mode) or GND_{ext} (insulated mode). The internal resistor of the connected device is not allowed to have less than 490 Ohms in order to not exceed the given current limits.

DOut0..DOut3 provide LOW signal level by default, DOut4..DOut7 provide HIGH level by default. These levels are valid immediately on power-up of the card.

6.4.1.1 Marking On-The-Fly Signals

Digital inputs 0 and 1 can be used as position encoder signal inputs for marking on-the-fly applications. Here 90 degree phase-shifted input pulses are expected signalling motion direction and position change:



When these pulses are generated from a motion stage that moves the working piece, the resulting position information is used in marking on-the-fly mode to correct the marking positions accordingly. Resulting from that, marking will follow motion as far as available scanhead range and working area allows it. The pulses generated out of the encoder signals have to be multiplied with a factor reflecting the resolution of the used encoder. To set up and adjust a marking on-the-fly-system properly, following steps have to be performed:

- 1. Connect encoder signals A1 and B1 to DigIn0 and DigiIn1 and configure E1701 controller for encoder usage (either from within BeamConstruct or via programming interface as described below)
- 2. Mark a square without any encoder signals feed into the controller
- 3. When the square does not have exact size and/or is distorted, modify correction table and/or gain settings
- 4. Mark the same square with a slow motion (using encoder pulses)

- 5. When the square is damaged (means open on one side or compressed) the on-the-fly-factor has to be changed (set to a smaller or higher value)
- 6. Mark the same square with a fast motion (using encoder pulses)
- 7. When the square is damaged (means open on one side or compressed) the on-the-fly-factor has to be changed (set to a smaller or higher value)

The on-the-fly-factor controls the strength of compensation and is the relation between speed of external device/encoder pulses and card-internal compensation calculation. When this factor is wrong, the marking results are distorted. For a square (as recommended to be used in calibration steps above) following results are imaginable:



The left drawing shows an over-compensated system, here the internal compensation is too strong, the factor is too big. The right drawing shows an under-compensated set-up, here the factor is too small causing a too weak compensation. Only when marking result is really a square, the on-the-fly-factor is correct.

When "tune"-flag 2 is set, a second encoder can be used for 2D marking on-the-fly applications (requires firmware 25 or newer). In this mode digital inputs 0 and 1 (encoder inputs A1 and B1) correspond to X axis and on-the-fly factor for X direction. Additionally digital inputs 2 and 3 (encoder inputs A2 and B2) correspond to Y axis and on-the-fly factor for Y direction. Operation principle is the same as for 1D on-the-fly described above: the incremental values received from the encoders for X and Y are added to the current X and Y coordinates to be marked. Procedure for adjusting the encoder factor is also the same, here it is recommended to perform this operation for X and Y movements separately and finally try both motion directions together.

6.4.2 Opto-Configuration

Using these jumpers the operation mode for digital I/Os 0..7 can be chosen. When they are set, the optocouplers are powered internally. In this mode it is not working in opto-insulated mode and I/Os are using CMOS level signals.

When they are not set, external power and ground has to be provided at 20 pin connector (as described above) and these digital I/Os are working in electrically insulated, opto-coupled mode.

6.4.3 Input State LEDs

These 8 yellow LEDs show the state of corresponding 8 digital inputs. As long as a HIGH signal is detected on an input, the related LED is turned on.

6.5 E1701 Secondary Head Extension Board

The E1701 Secondary Head Extension Board can be used up to three times with the same E1701D Baseboard to have a scanner controller system with up to four heads connected. These additional scanheads work fully parallel to the primary scanhead of E1701D baseboard.



It provides following features:



- 1. XY2-100 or XY3-100 signals for scanhead
- Extension connectors more extension boards can be placed here in order to add some more 2. functionality and hardware interfaces to the board, please refer to related section in description of baseboard above

6.5.1 Scanner Signals

The white 26 pin connector provides XY2-100-compliant signals to be used to control up to three galvos of a scanhead. It can be connected to an XY2-100 compatible scanner system directly and without further modifications when a 1:1 connection to a D-SUB25 connector is used. The connector is a white one to avoid confusion when a LP8 Extension Board is used too.

The connector provides following signals:

Upper Row Of Pins	Signal	Voltage	Remarks	Lower Row Of Pins	Signal	Voltage	Remarks
1	CLK-		XY2-100-/	2	CLK+		XY2-100-/
3	SYNC-		XY2-100-E-	4	SYNC+		XY2-100-E-
5	X-		compatible	6	X+		compatible
7	Y-		signals	8	Y+		signals
9	Z-			10	Z+		
11				12			
13				14			
15				16			
17			do not	18			do not
			connect!				connect!
19			donot	20	GND	GND	XY2-100-/
			connect!				XY2-100-E-
21	GND	GND	XY2-100-/	22	GND	GND	compatible
			XY2-100-E-				signals
			compatible				
			signais				
23			donot	24			donot
			connect!				connect!
25			do not	26			do not
			connect!				connect!

Comparing to E1701D Baseboard this connector does not provide any laser signals (like LaserGate, LaserA or LaserB). Since this scanner output works completely parallel to the one from E1701D Baseboard it has to be used together with the same laser using beam splitters.

When operated in XY3-100 mode, the related signals are provided at the white 26 pin connector. It can be connected to an XY3-100 compatible scanner system directly and without further modifications when a 1:1 connection to a D-SUB25 connector is used. The connector is a white one to avoid confusion when a LP8 Extension Board is used too.

Upper Row Of Pins	Signal	Voltage	Remarks	Lower Row Of Pins	Signal	Voltage	Remarks
1	A-		XY3-100-	2	A+		XY3-100-
3	B-		compatible	4	B+		compatible
5	C-		signals	6	C+		signals
7	D-			8	D+		
9				10			
11				12			
13				14			
15				16			
17			do not	18			do not
			connect!				connect!
19			do not connect!	20	GND	GND	XY2-100-7 XY2-100-E-
21	GND	GND	XY2-100-/ XY2-100-E- compatible signals	22	GND	GND	compatible signals
23			do not connect!	24			do not connect!
25			do not connect!	26			do not connect!

The connector provides following signals:

Comparing to E1701D Baseboard this connector does not provide any laser signals (like LaserGate, LaserA or LaserB). Since this scanner output works completely parallel to the one from E1701D Baseboard it has to be used together with the same laser using beam splitters.

6.5.2 Extension Connectors

The two extension connectors on each side of the board can be used to place extension boards with additional peripheral interfaces. For a description of handling and usage of these connectors please refer above.

6.6 E1701dock Extension Board

The E1701 dock is an expansion board which either can be mounted on very top of the E1701 (using hex-stands or distance bolts) or which can be mounted near to it (e.g. by using a second E170Xbase). It has to be wired with simple 1:1 flat-belt cables to the E1701 controller card. Dependent on which extension boards are available, the E1701dock provides some easy to use interfaces for connecting external equipment without the need to have own, complex wiring. Or in other words: when E1701dock is used, it acts as some kind of breakout-board, lasers and scanheads can be connected quite easy, only a few 1:1 cables need to be plugged.

PLEASE NOTE: prior to using the E1701dock, please ensure the pinout of the connectors (as described below) really fit to your specific variant of your used laser. Elsewhere irreversible damage are possible at laser and/or scanner controller card.

PLEASE NOTE: when using the laser and/or digital signals (from LP8 or Digi IO extension board) in parallel, you need to ensure they are not used twice, out of both connectors. This may otherwise result in an undefined and unwanted behaviour as they work parallel and can't be switched separately. When a parallel usage is intended, please double-check the current consumption of connected devices as the total current that can be provided by these lines does not double but is the same total value for two connections then. Exceeding the total maximum allowed current of a E1701-signal may cause an irreversible damage to the controller otherwise.

6.6.1 E1701dock Connectors

On top side the E1701dock provides the following connectors:



1. E1701D baseboard connector

This connector has to be wired with a 1:1 connection to the E1701D baseboard (laser and scanner connector as described in section "6.1.9 Laser/Scanner Signals") PLEASE NOTE: this connector does not fit to the ILDA interface connector of E1701A electrically and is not allowed to be used with it!

2. E1701A/D LP8 connector

This connector has to be wired with a 1:1 connection to the LP8 extension boards interface (as described in section "6.3.2 Laser Signals"); in case additional signals of the LP8 extension need to be used elsewhere, a flat-belt cable can be used that comes with three IDC-plugs on it. Then one plug can be connected to the LP8 extension board, one to the E1701dock and the third one to some additional hardware making use of this interfaces signals. In this case please ensure no signals are double-used and no short-circuits are caused on input lines, otherwise the controller card, the E1701dock and/or the connected hardware may be damaged irreversibly!

3. E1701A/D Digi I/O connector

This connector has to be wired with a 1:1 connection to the Digi IO extension boards interface (as described in section "6.4.1 Digi I/O"); in case additional signals of the Digi I/O extension need to be used elsewhere, a flat-belt cable can be used that comes with three IDC-plugs on it. Then one plug can be connected to the Digi IO extension board, one to the E1701dock and one to some additional hardware making use of this interface. In this case please ensure no signals are double-used and no short-circuits are caused on input lines, otherwise the controller card, the E1701dock and/or the connected hardware may be damaged irreversibly!

The Digi I/O connector needs to be wired only in case

- a MOPA laser is connected and at least one of the alarm feedback signals is used or
- A YAG/CO $_{\rm 2}$ laser is connected and the shutter control signal is used

PLEASE NOTE: depending on the connected laser and the jumpers (8), some of the digital inputs are used from within the E1701dock! In this case the related signals should not be used for anything else, otherwise the controller card, the E1701dock and/or the connected hardware may be damaged irreversibly by a short-circuit! For more details please refer to the pinout of the laser connectors (5 and 6) and the description of the jumpers (8) below.

4. XY2-100/XY3-100 connector

In case the E1701dock is used with the E1701D controller card, this interface can be used to connect a XY2-100/XY3-100 scanhead directly. Here only a 1:1 D-SUB25 cable is needed. On this connector both, the XY2-100/XY3-100 signals as well as the optional power from the screw terminal (10) are provided. When a scanhead does not support power supply via the D-SUB25 cable, the power input at the screw terminal (10) can be left unused. This connector provides the standard pinout for XY2-100/XY3-100 connectors so that all compliant scanheads can be connected directly:

XY2-100 pinout	XY3-100 pinout		
CLK- SYNC- X- X- Z- 5 (CLK+ 15 SYNC+ 16 X+ 17 Y+ 18 Z+ 7 20 19 20 21 Y- 4 CLK+ 15 SYNC+ 16 X+ 2- 5 (CLK+ 15 SYNC+ 16 X+ 2- 19 20 CLK+ 10 2- 2- 2- 2- 2- 2- 2- 2- 2- 2-	$\begin{array}{c} A \\ B \\ C \\ D \\ C \\ D \\ C \\ C \\ C \\ D \\ C \\ C$		

5. MOPA laser connector

This connector of the E1701dock can be used with most MOPA/fiber lasers such as IPG YLP interface types G (without SPI serial interface and pin 12 alarm signal), E (without APD indexing), D, D1, B, B1, MaxPhotonics MFP, JPT YDFLP, Raycus RFL-PMX, Raycus RFL-PQB and compatible laser types. Connection between E1701dock and laser is done mainly via a 1:1 D-SUB25 cable. The connector provides the following pinout:

Pin	Description	Pin	Description
1	LP8_0 laser power signal, CMOS, max 8mA	14	GND
2	LP8_1 laser power signal, CMOS, max 8mA	15	Not connected
3	LP8_2 laser power signal, CMOS, max 8mA	16	DIn6 laser alarm pin 16, available at DIn6 of Digi I/O extension only when jumper "DIn6/ER16" is set (refer to description below)
4	LP8_3 laser power signal, CMOS, max 8mA	17	Not connected
5	LP8_4 laser power signal, CMOS, max 8mA	18	MO main oscillator signal, CMOS, max 8mA
6	LP8_5 laser power signal, CMOS, max 8mA	19	LaserGate power amplifier signal, CMOS, max 14mA

7	LP8_6 laser power signal, CMOS, max 8mA	20	LaserA 5V pulse repetitive signal, CMOS, max 14mA
8	LP8_7 laser power signal, CMOS, max 8mA	21	DIn7 laser alarm pin 21, available at DIn7 of Digi I/O extension only when jumper "DIn7/ER21" is set (refer to description below)
9	LP8 Latch laser power latch, CMOS, max 8mA	22	LaserB used to switch the pilot laser, CMOS, max 14mA
10	GND	23	Emergency input, connected to screw connector (10), has to be pulled to HIGH for different laser types to enable operation
11	DIn5 laser alarm pin 11, available at DIn5 of Digi I/O extension only when jumper "DIn5/ER11" is set (refer to description below)	24	Not connected
12	Not connected	25	Not connected
13	Not connected		

The signals on this connector are available only when LP8 extension and optionally Digi I/O extension is used.

6. YAG/CO₂ laser connector

This is a connector for direct connection to laser. A connection can be established using a standard 1:1 D-SUB-cable. This connector provides the following pinout which is typically to most common YAG or CO_2 lasers:

Pin	Description	Pin	Description
1	Not connected	14	Not connected
2	Not connected	15	Not connected
3	GND	16	Not connected
4	Emergency input, connected to screw connector (10) and has to be pulled to HIGH for different laser types to enable operation	17	GND
5	GND	18	GND
6	GND	19	GND
7	Shutter control, this pin is connected to DOut7 of the Digi IO extension	20	LaserB first pulse killer signal (FPK/QKILL for YAG lasers) or pilot laser output (for CO2 lasers), CMOS, max 14mA
8	GND	21	AOut1 power control, analogue signal in range 010V, max 15mA
9	AOut0 frequency control, analogue signal in range 05V, max 15mA; this signal is hardware-divided by 2 comparing to the original AOut0	22	LaserA 5V output, CMOS, max 14mA
10	GND	23	MO used to switch the pilot laser, CMOS, max 8mA
11	GND	24	LaserGate non-inverted/high-active laser-on signal, CMOS, max 14mA
12	LaserGate inverted/low-active laser-on signal, CMOS, max 40mA	25	LaserA negative +-5V output of differential PWM signal (PWM-, also connected to shield of BNC-connector/9)
13	LaserA positive +-5V output of differential PWM signal (PWM+, also connected to core of BNC-connector/9)		

The signals on this connector are available only when E1701D and/or LP8 extension and optionally Digi I/O extension is used.

7. Start/Stop input connector

This connector can be used only together with E1701D controller board and provides easy access to the ExtStart and ExtStop input pins (as described in section "6.1.9 Laser/Scanner Signals"). The connector requires a JST PH3P type plug and comes with following pinout:

1	2	3

- 1 ExtStart input
- 2 ExtStop input

3 - +5V output to be used with ExtStart and ExtStop

8. MOPA alarm signal jumpers

These jumpers can be set when a MOPA laser is connected via (5) and the alarm feedback signal of this laser has to be used. For each of the lasers alarm lines that is intended to be read back, the related jumper has to be set (for details please refer to the pinout of connector 5 above and the manual of your laser).

Starting with hardware version 1.4 a fourth jumper is available for these laser types that provide an other error signal via pin 12 of the laser connector. This jumper is a solder jumper which can be found on bottom side of the E1701dock (marked in blue in image above) and which is named as "ER12 DIn4". PLEASE NOTE: when a jumper is set here, the related digital input of the Digi IO extension can't be used as input any more! Doing so can cause a short-circuit and may damage the scanner controller card, the E1701dock and/or the external equipment feeding a signal into DIn5/DIn6/DIn7. Reading back the laser alarm signals requires the Digi IO extension

9. BNC-connector for PWM/tickle-signal

It provides a differential +-5V LaserA signal which is also available as PWM+/PWM- at the D-SUB25 connector (pins 13 and 25 of connector 6) and which can be used for all PWM-controlled lasers such as YAG or CO_2

10. Power supply and enable signal connector

This connector can be used to supply power to a connected XY2-100/XY3-100 scanhead (E1701D only) and to apply an enable signal to a connected laser (E1701A and E1701D). It has following pinout:

Pin	Name	Description
5	-30V	Power supply to scanhead, to be used only with E1701D controller board, is directly connected to pins 9, 10 and 22 of (4); this input voltage does NOT supply the controller board
4	GND	Common and scanhead ground, is directly connected to pins 11, 23 and 24 of (4)
3	+30V	Power supply to scanhead, to be used only with E1701D controller board, is directly connected to pins 12, 13 and 25 of (4); this input voltage does NOT supply the controller board
2	5V	5V output from scanner controller card, can be used e.g. to feed EMRG input (e.g. via contact of a relay). Please note: The "5V" pin of this screw connector is not allowed to be used for supplying power to any other peripherals.
1	EMRG	Emergency/enable input for lasers, this pin is directly connected to pin 4 of YAG/CO ₂ connector (6) and pin 23 of MOPA connector (5).

In case the three inputs 3, 4 and 5 are connected to a bipolar power supply providing +-12..+-30V to power the connected scanhead, the input voltage is feed to the scanhead directly via the XY2-100/XY3-100 connector but not to the scanner controller card. Here the input voltage has to be equal to the voltage required by the scanhead (typically +-15V or +-24V). Power supply needs to provide 1A plus current required for connected scanhead.

When no power supply with symmetric/bipolar outputs is available, it is possible to combine two standard power supplies. Here GND of the first power supply has to be connected with +V of the second power supply and with the GND-screw-connector of E1701dock according to following scheme:





ATTENTION: When connecting wires to the screw terminals, do not transmit any force to the PCB where the green connector is soldered at! While screwing tight the wires, hold the connector by hand to catch the force but **do not hold the PCB only!**

11. Starting with hardware version 1.4, on bottom side (marked in blue) there is a solder jumper "JP17" which applies +5V to pin 17 of the MOPA laser connector when closed. This jumper should be closed ONLY when the connected laser expects a voltage input at this pin in order to operate some internal functions.



ATTENTION: Closing this pin when the connected laser does not expect this voltage input may cause irreversible damage to the hardware!

Right beside the solder jumper there is a pinhole which can be used to solder in a wire **when the solder jumper is not closed**. This pinhole, named as P17, is directly connected to pin 17 of the MOPA D-SUB25 connector. It can be used to apply any other, custom signal to that pin (depending on what the laser expects here).

ATTENTION: applying any other signal to P17 while JP17 is closed may cause a short circuit with the 5V rail of the controller and may cause irreversible damage to the hardware!

When you are unsure about the usage of the JP17 solder jumper and/or the P17 wire soldering point, please contact HALaser Systems first!

6.6.2 E1701dock Wiring

The E1701dock can be mounted on top of a E1701-stack using hex-stands or distance bolts like shown in picture below. There E1701D is mounted on an E170Xbase (optional) to make use of a DIN-/C45-rail while the E170dock is placed on very top. Connection between E1701 controller and its extension boards is done via short, 1:1 flat belt cables:



Following all possible configurations are listed including the flat-belt cables that are needed for connection to E1701dock, given cable lengths are valid when E1701dock is placed on top:

Configuration	Supported Lasers	Wires E1701A	Wires E1701D
Baseboard only	CO ₂ /YAG/all PWM- driven laser types	Not supported	• 1x 1:126-pin flat-belt cable, 5 cm length from baseboard to E1701dock (white connectors)
Baseboard plus LP8 Extension	Fiber/MOPA/CO ₂ / YAG/all PWM-driven laser types	 1x 1:1 26-pin flat-belt cable, 4,5 cm length from LP8 Extension to E1701dock 	 1x 1:126-pin flat-belt cable, 4,5 cm length from LP8 Extension to E1701dock 1x 1:126-pin flat-belt cable, 7,5 cm length from baseboard to E1701dock (white connectors)
Baseboard plus Digi I/O Extension	XY2-100 output on D-SUB25	Not supported	• 1x 1:126-pin flat-belt cable, 6,5 cm length from baseboard to E1701dock (white connectors)
Baseboard plus Digi I/O Extension plus LP8 Extension	Fiber/MOPA with error feedback, CO ₂ /YAG/all PWM- driven laser types	 1x 1:1 20-pin flat-belt cable, 3,5 cm length from Digi I/O Extension to E1701dock (only needed when MOPA error feedback is required) 1x 1:1 26-pin flat-belt cable, 6 cm length from LP8 Extension to E1701dock 	 1x 1:1 20-pin flat-belt cable, 3,5 cm length from Digi I/O Extension to E1701dock (only needed when MOPA error feedback is required) 1x 1:1 26-pin flat-belt cable, 6 cm length from LP8 Extension to E1701dock 1x 1:1 26-pin flat-belt cable, 9 cm length from baseboard to E1701dock (white connectors)

6.7 E170Xbase

The E170Xbase extension is a mounting help for easy installation on DIN rails/C45 rails and other possibilities of mechanical integration into machines:



RED – mounting positions for DIN/C45 rail locks/DIN/C45 rail adapters (bottom side). Pairs of locks can be mounted in one of 2 possible orientations. Here locks of type Phoenix Contact 1201578 or similar can be used. With these locks the board then can be clamped on a DIN/C45 rail.

BLUE – mounting holes for the E1701A or E1701D scanner controller card on top of the E170Xbase in one of two possible orientations. These holes are symmetrically arranged so that the board can be mounted by 180 degrees rotated. Here hex stands/distance bolts with M3 threads (or similar) can be screwed in where the controller card is mounted on top.

GREEN – optional; mounting holes for a HALdrive converter board (top side) instead of an E1701X scanner controller card, here hex stands/distance bolts with M2 threads (or similar) can be screwed in where the HALdrive is mounted on top.

Mounting procedure for E170Xbase:

- 1. Identify suitable positions (RED) for two DIN/C45 rail locks and mount them on bottom side (two or three screws from top side into the lock on bottom)
- 2. Mount hex-stands or distance bolts in at least four of the given mounting holes (BLUE).
- 3. Mount E1701A or E1701D on top of these hex-stands/distance bolts
- 4. Clamp the board on your DIN/C45 rail

Without the DIN/C45 rail clamps the board also can be used as top-cover for the E1701A or E1701D.

7 Quick Start into E1701A/D

Following a few steps are described that give users the possibility to quick start into usage of E1701A/D scanner controller. It makes use of BeamConstruct and the (slow) USB connection. For this quick start manual it is assumed correct wiring of the controller is already done according to the description above. For more detailed information about BeamConstruct usage please also refer to quick start manual from https://halaser.systems/download/manual_quickstart.pdf and to full user manual which is available at https://halaser.systems/download/manual.pdf.

To start with E1701A/D controller:

- 1. **SECURITY CHECK:** The following steps describe how to set up E1701A/D scanner controller card and how to control laser equipment with them. Thus all laser safety rules and regulations need to be respected, all required technical security mechanisms need to be available and active prior to starting with it.
 - 2. Install latest software version from <u>https://halaser.systems/download.php</u> for Windows this package contains all required drivers, for Linux no separate drivers are needed.
 - 3. Connect E1701A/D controller via USB. For E1701A external +-15V power supply is required (as described above).
 - 4. Now the Alive-LED should light up and then start blinking after some time. When this does not happen, please turn power off, check if the microSD-card is placed correctly and then try again.
 - 5. Evaluate the serial interface the controller is connected with for Windows the Device Manager (can be found in Control Panel) will list a new COM-port (e.g. "COM3"); for Linux type "dmesg" in console to find out to which interface it was connected with (typically "/dev/ttyACM0").
 - 6. Start BeamConstruct laser marking software.
 - 7. Go to menu "Project" \rightarrow "Project Settings...", then tab-pane "Scanner".
 - 8. Now you can either select "E1701A" as scanner controller card or can go with "E1701D" which is selected and preconfigured by default. If none of both is selected, please choose the appropriate scanner controller in the related combo box.
 - 9. Press the "Configure"-button to get into the settings dialogue for E1701A/D plug-in.
 - 10. Enter the serial interface name in field "IP/Interface" (e.g. "COM3" or "/dev/ttyACM0").
 - 11. Leave everything with "OK".
 - 12. Draw some geometries as described in "BeamConstruct Quick Start Manual".
- 13. **SECURITY CHECK:** Next the scanner controller card will be accessed for the first time. That means it is opened and initialised and all connected equipment may start working now. Thus it is very important to ensure all security regulations are met and nobody can be injured and no damage can be caused also in case laser output or other motion starts spontaneously and unexpectedly!
- 14. Press "F2" or go to menu "Process" \rightarrow "Mark" to open the mark dialogue.
- 15. Start marking by pressing the yellow button with the laser-symbol



8 Command Interface

The commands described in this section require firmware version 12 or later.

When E1701 scanner card is connected via USB and the USB-connection is NOT used for transmitting marking information, it can be used to send control commands to the card. Some of them are independent of the current operating mode and some of them can be used only in case the controller is operating in stand-alone mode. Starting with firmware version 15 control commands can also be sent via Telnet using Ethernet connection. Here a Telnet-client has to connect to port 23 using the IP of the scanner controller. This Telnet client should work in passive mode. So when E1701 scanner card is connected via Ethernet and the Ethernet-connection is NOT used for transmitting marking information, it can be used to send control commands to the card. Some of them are independent of the current operating mode and some of them can be used only in case the controller is operating in stand-alone mode.

Such a control command always consists of ASCII-text. An appropriate client has to connect to the serial port (COMx for Windows and /dev/ttyACMx for Linux where "x" is a number identifying the specific serial interface or TCP/IP port 23). As soon as the connection is established, commands can be sent to the card. All commands come with following structure:

cxxxx <parameter(s)>

The commands always start with character "c". Next four characters identify the command itself. Depending on the command one or more optional or mandatory parameters may follow. The command always returns with an "OK" or with an error.

8.1 General Commands

The following commands can be used in all scenarios, they do not depend on a specific operation mode of the card. Nevertheless it is recommended to not to send commands excessively during card is marking, to not to influence marking operation.

cvers

"version" – return version information of the controller card. This command returns a version string specifying version of hard- and firmware in style vFF-H where "FF" is the version of the firmware and "H" specifies the hadware revision of the controller.

cecho <0/1>

"echo" – when typing commands in a serial console communicating with the controller, all the typed characters are echoed, means they are sent back to the host so that a user can see what is typed. This may be an unwanted behaviour when an application communicates with this interface. Using this command the serial echo mode can be turned off (parameter 0, only return values are sent back) or on (parameter 1, all data are sent back). When called with no parameters, the current echo mode value is returned. Example: cecho 0 – turn off echo mode

cgbds

"get boards" – get an identifier value for the connected boards. This command returns a decimal number which depends on the connected extension boards and can be used to identify them. The returned value is a sum consisting of the following numbers:

1 - XY2-100/XY3-100 baseboard (E1701D) is available

2 - analogue baseboard (E1701A) is available

256 – LP8 Extension Board is available

512 – Digi I/O Extension Board is available

cglog

"get logline" – returns a single logging line. This command has to be called repeatedly until an error is returned to get logging information from the controller. On each call of this function one logging line is

returned. When "cglog" isn't used for a longer time it may be possible the internal log-buffer has overrun. In this case "cglog" will not return all log information, previous log data may be overwritten.

cgbsr

"get board serial number" – returns the serial number of the card. This number is an unique, internal value that is used e.g. to identify a controller on host PC when more than one scanner card is used.

8.2 Stand-Alone Control Commands

Following commands are useful in case scanner controller is operating in stand-alone mode where marking data are loaded from microSD-card using special EPR-fileformat.

cstop

"**stop**" – stop marking as fast as possible. A running marking operation is stopped and LaserGate is turned off.

chalt <0/1>

"halt" - halts or continues the processing and output of marking data. When given parameter is equal to 1, marking is stopped next time the laser is off but no vector data are dropped. On continue (parameter equal 0) controller continues processing at the point where halt occurred. When marking is stopped with cstop the halt-condition is cleared too, means on next transmission of new marking data they are processed without the need to explicitly continue operation by calling chalt 0.

cstrt

"start" – start marking operation. This command can be called only when no marking operation is running and when a valid project (.epr) file was loaded. In this case the currently loaded project is marked once.

ctrig

"trigger" – send an external trigger signal by software. When scanner card is in state "marking" but waiting for an external trigger, this command releases this trigger. So behaviour is the same like a rising edge on the ExtStart input of the controller card.

cstat

"**stat**e" – return the current state of the card. This command returns one of the following texts identifying the operational state:

- marking card is processing some marking data currently, means either actively outputting them or waiting for an external trigger to start marking
- stand-alone controller is in stand-alone mode
- idle card is waiting and not marking
- waiting a project file was loaded, is ready for execution and waits for a trigger signal (either via ExtStart input or via command "ctrig")

cgtin

"get trigger inputs" – get the state of the external input signals. This command is not related to digital inputs of Digi I/O extension board but provides information regarding signal state of external start and stop. It returns a value that specifies which of these input signals are currently HIGH:

- 0 ExtStart and ExtStop are both LOW
- 2 ExtStart is HIGH
- 4 ExtStop is HIGH
- 6 ExtStart and ExtStop are both HIGH

cscor <idx>

"set correction" - specifies a new index for a previously loaded correction file (see description of configuration parameter <code>corrtable</code> in section "6.1.8 microSD-Card" above). The parameter <code>idx</code> can be a value in range 0..15 and needs to correspond to a previously loaded correction table. The newly set correction table applies to all vector data which are processed after this call. Thus it is recommended to use it only when marking operation was stopped – elsewhere it is not predictable how many vector data already have been precalculated with the previous correction table and starting with which vector data the new correction file is used.

When a idx-value is set which corresponds to no correction file data, no more correction is performed on vector data.

This command requires firmware version 33 or newer.

cgcor

"get correction" - this command is the counterpart of cscor and displays the index number of the currently used correction file

This command requires firmware version 33 or newer.

clepr <path>

"load **epr**" – loads an EPR stand-alone file from microSD card for outputting it on next marking operation. This command can be executed in stand-alone mode only.

When operating in stand-alone mode "idxselect", the command expects a number as parameter which specifies the index file to be loaded.

When operating in stand-alone mode "ioselect" or "iohaltedloop", the command is not supported. When operating in any other stand-alone mode, the command expects the path to the file to be loaded as parameter. Since this is the only parameter, no quotes are allowed for the pathname. The pathname itself has to be in format

0:/filename.epr

where 0:/ specifies the microSD-card and .epr is the standard extension of E1701 stand-alone marking data files (this name is a shortcut for "E1701 Processing Data"). During loading the ready-for-marking output signal is turned off and it is turned on only in case the file could be loaded successful (please refer to related section above).

Examples: clepr 0:/test.epr - loads a stand-alone file "test.epr" from microSD card

cgepr

"get epr" – returns the name of the currently loaded stand-alone file or an error "no file specified" when no file is loaded.

cdepr <path>

"delete epr" – deletes an EPR stand-alone file and all related, additional files from microSD card. This command can be executed in stand-alone mode only.

When operating in stand-alone mode "idxselect", the command expects a number as parameter which specifies the index file to be loaded.

When operating in stand-alone mode "ioselect" or "iohaltedloop", the command is not supported. When operating in any other stand-alone mode, the command expects the path to the file to be delete as parameter. Since this is the only parameter, no quotes are allowed for the pathname. The pathname itself has to be in format

0:/filename.epr

where 0:/ specifies the microSD-card and .epr is the standard extension of E1701 stand-alone marking data files (this name is a shortcut for "E1701 Processing Data"). Deleting is done asynchronously, so the returned "OK" only verifies the command was accepted. Successful deletion of the file can be assumed after 0,5 seconds. Examples: cdepr 0:/test.epr - deletes a stand-alone file "test.epr" from microSD card. When additional files test.dat (which may contain related dynamic data) and test.ser (which may hold serial number information) exist, they are deleted by this command too.

This command requires a firmware version 43 or newer.

ctlxy <x> <y> <z>

"turn on laser at given XYZ position" – lets the scanner move to a specific position and turns on the laser as long as ExtStart is HIGH

This command requires stand-alone mode "auto". It can be used to turn on the laser as long as the ExtStart input is at HIGH. So using this function some externally controlled drilling or cutting operations are possible. As parameter it expects the X, Y and Z coordinate positions to jump to (in unit 26 bits). The sequence of commands to use this function are as follows:

- unload the current project file ("e.g. by calling "clepr 0:/notexist.epr")
- call "ctlxy" together with the 26 bit XYZ position the scanner has to jump to → the parameters used for jumping are the ones out of the last EPR file executed
- the state-flag E170X CSTATE SAC CTLXY is set
- the state-flag E170X_CSTATE_SAC_READY is set as soon as the scanner has arrived at the specified XYZ position, this happens together with the output DOutO:
- wait until DOut0 goes to HIGH → this output signals the specified XYZ position was reached and the controller is able to turn on the laser now
- pull ExtStart to HIGH → the laser is turned on within 1 usec at max using the laser parameters out of the last EPR file executed
- as long as ExtStart is HIGH, the laser is turned on and DOut1 is at HIGH and the state-flag E170X CSTATE SAC MARKING is set
- pull ExtStart to LOW as soon as the laser has to be turned off → both DOut0 and DOut1 are pulled to low, the laser is turned off within 1 msec at max and all E170X CSTATE SAC -flags are reset
- now the complete sequence has ended ad the ctlxy-command has elapsed. To turn on the laser via ExtStart again, a new command ctlxy has to be issued

Example:

ctlxy 33554432 33554432 33554432 Starts a ctlxy-sequence as described above with the scanner moved to the centre position.

This command requires firmware version 40 or newer.

csbuf <idx> <path>

"set buffer" - this command works similar to the configuration parameter "iobuff" and can be called in stand-alone modes "ioselect" and "idxselect". It can be used to preload EPR stand-alone data files into memory so that they can be accessed faster and without additional accesses of the SD card. The first parameter <idx> is mandatory and specifies the slot the EPR file has to be loaded to. Different to parameter "iobuff" where the slot number is given automatically and where the index value can be in range 1..255, here the slot number and the index number are always the same and are in range 1..20. So only the first 20 index values can be used together with this dynamic loading function. When only <idx> is given, the loaded file is 0:/<idx>.epr. Optionally also a file name <path> can be given in format 0:/file.epr. In this case the given file is loaded to the slot specified by <idx> and can be accessed with the related index number. After every call to csbuf the command cgbuf has to be executed repeatedly until it returns -1.

Examples:

csbuf 3 - loads the file 0:/3.epr from SD-card and stores it in slot number 3 so that it can be accessed either via "clepr 3" (in stand-alone mode "idxselect") or via a digital input pattern at the Digi I/O Extension representing a 3 (in stand-alone mode "ioselect)

csbuf 5 0:/markme.epr - loads the file 0:/markme.epr from SD-card and stores it in slot number 5 so that it can be accessed either via "clepr 5" (in stand-alone mode "idxselect") or via a digital input pattern at the Digi I/O Extension representing a 5 (in stand-alone mode "ioselect)

This command requires firmware version 36 or newer.

cgbuf

"get processed buffer" - returns the index number of the buffer that is currently processed by a previous call to cgbuf. As long as this command returns a value greater than -1, no other calls to csbuf are

allowed. The returnend number specifies the index/slot number that is currently filled with data. When cgbuf returns -1, the loading operation has been finished.

This command requires firmware version 36 or newer.

cjsor <percentage>

"jump speed override" – changes the speeds of all jump speed values by the given factor. Here parameter percentage has to be given in unit 1/100%. The override-value specified by this command remains active until it is set back to normal value by calling "cjsor 10000" or until the controller is rebooted. The value given here is active for all processed data including host-controlled marking projects and stand-alone files loaded from microSD card.

This command requires firmware version 25 or newer.

cmsor <percentage>

"mark speed override" – changes the speeds of all mark speed values by the given factor. Here parameter percentage has to be given in unit 1/100%. The override-value specified by this command remains active until it is set back to normal value by calling "cmsor 10000" or until the controller is rebooted. The value given here is active for all processed data including host-controlled marking projects and stand-alone files loaded from microSD card.

This command requires firmware version 25 or newer.

cpwor <factor>

"power overwrite" - this command modifies the actual power by using the given factor (in unit 1/100%). All operations make use of the changed power until a factor of 10000 is set or until the controller is restarted. This is true for both, stand-alone applications where an .EPR-file is loaded from microSD-card and for hostcontrolled marking operations (via libe1701 or BeamConstruct).

This command influences following methods of setting laser power:

- pulse width, here user has to ensure the resulting pulse width is smaller than the period of the related frequency, elsewhere the output will be a continuous signal
- LP8 laser port
- AOut0 and AOut1 analogue outputs

cfror <factor>

"frequency overwrite" - this command modifies the actual frequency by using the given factor (in unit 1/100%). All operations make use of the changed power until a factor of 10000 is set or until the controller is restarted. This is true for both, stand-alone applications where an .EPR-file is loaded from microSD-card and for host-controlled marking operations (via libe1701 or BeamConstruct). This command is not available for lasermodes CO₂ or YAG

This command is not available for laser modes CO_2 of T

This function requires firmware version 42 or newer.

cpuor <factor>

"pulse-width overwrite" - this command modifies the actual pulse-width by using the given factor (in unit 1/100%). All operations make use of the changed pulse-width until a factor of 10000 is set or until the controller is restarted. This is true for both, stand-alone applications where an .EPR-file is loaded from microSD-card and for host-controlled marking operations (via libe1701 or BeamConstruct). This command is not available for lasermodes CO₂ or YAG, there the pulse-width is changed via command cpwor.

This function requires firmware version 42 or newer.

cgmtx

"get matrix" - return the four elements of the 2x2 output matrix. The members of the matrix are returned as four integers with a factor of 1000. So <u>returned v</u>alues of "1200 0 0 1200" are equal to a matrix

Which itself defines a scale factor of 1,2 in both, X and Y direction of the output. This function requires firmware version 38 or newer.

csmtx <m11 m12 m21 m22>

"set matrix" - set a 2x2 matrix which is used for the global output of the scanner card. This means, the values applied here influence the whole project which is currently be marked. Such a 2x2 matrix can be used to modify the X- and Y-scale, the rotation and the X- and Y-slant of the output. The matrix members m11, m12, m21 and m22 have to be given as integers which represent the matrix elements multiplied by 1000. As soon as a custom matrix is set via this command, all matrix values out of a loaded EPR file are ignored and only the matrix-values currently set are used. This includes gain and rotation correction settings which may be set in such an EPR file.

0.0

1.2

Example: csmtx 996 -87 87 996 - rotate the output by 5 degrees; these values are generated out of the unity matrix {1000, 0, 0, 1000} which was multiplied with the rotation matrix {cos(5)*1000, -sin(5)*1000, sin(5)*1000}

This function requires firmware version 38 or newer.

cswaf <factor>

Sets a factor in unit bits per mm that is used with all commands that specify some distance or position (such as cspof). When this factor is set to a proper value, the given positions/distances can be specified in unit um instead of bits. When a factor of 1000 is specified, the functionality is reset back to the default behaviour where position values have to be given in unit bits.

This parameter requires a firmware version 45 or newer.

cspof <x y z>

"set position offset" – sets a n position offset for the complete output. This function expects three parameters for the offset to be set in X, Y and Z-direction. The values to be given here are signed 26 bit, means they need to be in range -33554431..33554432. To reset the offset for one or more directions, a value of 0 has to be set. Please note: this offset is set prior to the matrix calculations which may be done when a custom output matrix is set using command csmtx. Resulting from that, the matrix calculation also applies to the offset defined here. So when the matrix e.g. defines a scale factor for the output, the offset values specified here are scaled by the same factor.

Example: cspof -16777216 0 0 - shift the output by a quarter of the whole available working area to the left.

This function requires firmware version 42 or newer.

cstxt <"elementname"> <"text">

"set text" - set a new text value to an element in currently loaded project. The parameters for this command both have to be given with quotes ("). Setting a text is possible only for dynamic elements like Datamatrix barcodes or texts. Here "elementname" is the name of the element that has to be modified (this is the same name like shown in element tree of BeamConstruct) and the new text to be set. The "text" itself can be a format string as used within BeamConstruct when a serial number input element is involved Example: cstxt "Barcode 1" "Hello :-)" - sets a new text "Hello:-)" for the element with name "Barcode 1"

cgtxt <"elementname">

"get text" – gets the currently used text value of an element in loaded project. The parameter for this command has to be given with quotes ("). Getting a text is possible only for dynamic elements like Datamatrix barcodes or texts.

Example: cgtxt "Barcode 1" - gets the text from the element with name "Barcode 1"

csser <"elementname"> <cnt>

"set serial number" – sets a new serial count value to an element in currently loaded project. The element name for this command has to be given with quotes ("). Setting a new count is possible only for dynamic elements like Datamatrix barcodes or texts that have a serial number input element assigned. Setting the value has to be handled with care, here every value can be specified independent if it fits to possibly exiting beat count values.

Example: csser "Text 2" 42 - set a new serial number count value 42 for element with the name "Text 2"

cgser <"elementname">

"get serial number" – gets the current serial count value from an element in loaded project. The element name for this command has to be given with quotes ("). Getting the count is possible only for dynamic elements like Datamatrix barcodes or texts that have a serial number input element assigned.

ciser <"elementname">

"increment **ser**ial number" – increments the current serial count value of an element according to its serial number parameters. The element name for this command has to be given with quotes ("). Incrementing the count is possible only for dynamic elements like Datamatrix barcodes or texts that have a serial number input element assigned. This function is more secure than forced setting of a new count value with "csser" since it can't violate the counting rules.

cdser <"elementname">

"decrement serial number" – decrements the current serial count value of an element according to its serial number parameters. The element name for this command has to be given with quotes ("). Decrementing the count is possible only for dynamic elements like Datamatrix barcodes or texts that have a serial number input element assigned. This function is more secure than forced setting of a new count value with "csser" since it can't violate the serial number counting rules.

crser <"elementname">

"reset **ser**ial number" – resets the current serial count value of an element to its start-value (according to its serial number parameters). The element name for this command has to be given with quotes ("). Resetting the count is possible only for dynamic elements like Datamatrix barcodes or texts that have a serial number input element assigned. This function is more secure than forced setting of a value with "csser" since it can't violate the predefined serial number parameters and automatically uses the correct reset value.

cstim <seconds>

"set time" – this command sets the system time to the value specified with the parameter. Here the number of seconds have to be specified that have elapsed since 01.01.1970 at 00:00:00. After sending this command the controller card operates at the given time. The time value is lost after next power cycle and has to be set again.

Example: cstim 1420113600 - set the internal time of E1701 controller to 01.01.2015 12:00:00, here 1420113600 represets the number of seconds that have been elapsed between 01.01.1970 00:00:00 and 01.01.2015 12:00:00

crtim

"retrieve **time**" – this command schedules time retrieval from an SNTP server asynchronously. It always returns with "OK" since the command is scheduled for execution during next working cycles. To use this command, controller has to be configured with IP, netmask, gateway and SNTP server IP correctly and needs to be able to access this SNTP server from its position in network. For details please refer to description of configuration parameters in section about microSD card above.

cgtim

"get time" – returns the current time of the board in number of seconds that have elapsed since 01.01.1970 at 00:00:00. After powering up the board and before a valid time has been set, this value is undefined.

cftim

"get formatted time" – returns the current time of the board as formatted string in style DD.MM.YYYY hh:mm:ss. After powering up the board and before a valid time has been set, this value is undefined.

cstyr <year>

"set time year" – sets the year of the current system time to the value given as parameter. This value has to be in range 1900..2038

cstmo <month>

"set time month" – sets the month of the current system time to the value given as parameter. This value has to be in range 1..12 according to the number of the month.

cstdy <day>

"set time day" – sets the day of the current system time to the value given as parameter. This value has to be in range 1..28, 1..30 or 1..31 according to the length of the current month. To avoid invalid combinations it is recommended to set the month (using command cstmo) before setting the day.

csthr <hour>

"set time hour" – sets the hour of the current system time to the value given as parameter. This value has to be in range 0..23.

cstmi <minute>

"set time minute" – sets the minute of the current system time to the value given as parameter. This value has to be in range 0..59.

cstsc <second>

"set time second" – sets the second of the current system time to the value given as parameter. This value has to be in range 0..59.

cgsta

"get serial state" – this command applies only when working in stand-alone mode with dynamic serial number data that change on every mark operation. It returns information if the state of serial numbers has changed and is not yet saved (in this case "pending" is returned) or if they have been saved and therefore do not get lost when power is turned off now ("saved" is returned in this case).

cssta

"save serial state" - this command applies only when working in stand-alone mode with dynamic serial number data that change on every mark operation. When it is called, a command to save the current state of serial numbers is enqueued and will be processed as soon as controller is able to store these data. So when this command returns with "OK" that doesn't necessarily means the serial number states are saved now. The current save state still has to be checked by calling cgsta after cssta has been issued.

crrrr

"reboot" – perform a warm reboot of the hardware and restart the firmware. Reboot is done immediately, means this command does not return anything but connection to the board will be interrupted as soon as it has been sent.

This command requires firmware version 19 or newer.

8.3 Hardware Commands

These commands can be used to access hardware signals directly. When these hardware outputs are set or unset while a marking operation is running, they may have no effect as they may be overridden immediately. Thus it is recommended to execute them only when the controller card is idle and no other operations are in progress. But also in this case, when a hardware output is set to a specific state, any operation (especially marking cycle) that is executed afterwards, may override that specific state-changes. Following hardware-specific commands are supported:

cginp

"get input" – get the current state of the digital inputs (in case a Digi I/O extension is available). The input state is returned as a decimal number representing the bitpattern at the inputs. So when e.g. a value "15" is returned, this means the lower four inputs are set to HIGH while the upper ones are at LOW level

csout <value>

"set **out**put" – set the state of the digital outputs (in case a Digi I/O extension is available). The output to be set is specified as a decimal number representing the bitpattern. When no parameter is given, the behaviour is undefined.

Example: csout 128 - set DOut7 at the Digi I/O extension board to HIGH while all others stay at LOW

cslgt <value>

"set LaserGate" - set the state of the LaserGate output either to HIGH (value is set to 1) or to LOW (value is set to 0).

This command requires firmware version 42 or newer.

cslmo <value>

"set MO" – set the state of the main oscillator output either to HIGH (value is set to 1) or to LOW (value is set to 0).

This command requires firmware version 42 or newer.

cslp8 <value>

"set LP8" – set the state of the LP8 output port to the value given as parameter. Here value is allowed to be in range 0..255, the related bits of the LP8 output are set according to the bitpattern of the specified number. This command requires firmware version 41 or newer.

8.4 Mark Control Commands

The following section describes commands that can be used to send marking data (including vector data and laser/scanner parameters) to the controller. They are available with all firmware version 15 or newer. These commands can be mixed with the commands described above but have a different structure:

- they always start with a character "d"
- the total length of one frame (means one command) is always 14 bytes
- they mustn't be terminated with CR/LF, the end of a frame is determined by its size of 14 bytes
- they contain binary, means not human-readable data and therefore can't be sent manually

Different to the programming interface ("9.1 E1701 Easy Interface Functions") mentioned below, this possibility to send control and marking data is completely independent from any host operating system and from any additional software or libraries. It gives the possibility to send marking data to the card right via some binary data which can be sent via Ethernet connection (Telnet) or USB serial interface.

PLEASE NOTE: when using Network/Telnet connection and when switching from a Mark Control Command ("d"-command) to a general command ("c"-command as described above) it is recommended to completely transmit all preceding output before sending a command of other type.

These commands always have the following structure:

dCAAAABBBBEEEE

d – marks starting point of a frame and identifies a mark control command with a fixed length of 14 bytes (including this character)

 $_{\rm C}$ – 8 bit value that specifies what command has to be executed

 ${\tt AAAA}$ – 32 bit little-endian value, it's meaning and usage depends on "C"

 ${\tt BBBB}$ – 32 bit little-endian value, it's meaning and usage depends on "C"

 $\tt EEEE-32$ bit little-endian value, it's meaning and usage depends on "C"

It is recommended to collect commands before they are sent to the controller, especially in case Ethernet connection is used. In case of TCP/IP the used payload length of a TCP-frame is 1460 bytes which should be filled as much as possible in order to avoid additional data transfers. So when sending larger amounts of data to the controller, up to 104 command frames should be collected and then sent all together (104 * 14 = 1456 bytes which is close to 1460).

From time to time the controller sends back an answer to give back some state information. In case of Ethernet/Telnet connection this answer is not sent periodically but as response to a complete block of data sent to the card. Since the size of such a block is not specified and depends on the underlying TCP/IP implementation (in case of Ethernet connections), no predictions can be made after what amount of data a response frame is sent. Thus it is recommended to try to receive such a response frame every time some data have been transmitted until at least one frame was received. When host software is idle, it can try to read response frames permanently. To trigger transmission of a new response frame, "ping" control command 0×0 A can be used (for details please refer below).

In case of USB/serial connection this response is sent automatically after every 14 byte frame submitted, so it is necessary to always read them in order to avoid overrun of receive buffers.

Such a response frame gives back information about the current operational state of the card and comes in following structure:

drlllssssiii

d – marks starting point of a response frame with a fixed length of 14 bytes (including this character), this character can be used to re-synchronise

R - 8 bit value, currently always 0xFF; this value has to be checked for future compatibility, in case it is not 0xFF the frame has to be ignored!

LLLL – 32 bit little-endian value, here the amount of free command buffer space is returned; sending application has to ensure this bufer never overruns, so it is recommended to always leave a space of at least 200 commands (recommended: 1000), new commands should be sent only when there is more space than this left in this buffer

SSSS – 32 bit little-endian value, signalling operational state; this calue can consist of following orconcatenated flags:

- 0x0000001 card is currently marking
- 0x0000002 the external start input is currently HIGH
- 0x0000004 the external stop input is currently HIGH
- 0x0000008 the external start input was set to HIGH after last response frame, this value is set only once for every rising edge on this input
- 0x0000010 the external stop input was set to HIGH after last response frame, this value is set only once for every rising edge on this input
- 0x0000080 the controller has received some data which may result in a marking operation; these data are currently processed but marking has not yet started
- 0x00000400 card is active but currently waiting for an external trigger to continue operation
- 0x00004000 card is active, writing some datat to the microSD card

IIII - 32 bit little-endian value, lower 8 bit show the actual state of digital inputs (in case Digi I/O Extension Board is a available), the upper 24 bits are reserved for future use.

Currently following mark control commands (identified by the 8 bit hexadecimal value for position "C" in a frame) can be sent to the controller:

Jump to Position

Move to a given coordinate position using the current jump speed and with laser turned off C = 0x00

AAAA = x-position to move to in range 0..67108863 BBBB = y-position to move to in range 0..67108863 EEEE = z-position to move to in range 0..67108863

Mark to Position

Move to a given coordinate position using the current mark speed and with laser turned on C = 0x01

AAAA = x-position to move to in range 0..67108863

BBBB = y-position to move to in range 0..67108863

EEEE = z-position to move to in range 0..67108863

Start output

This command has to be called at the end of every marking sequence to ensure marking output really starts. This is important in case only a few vectors are sent to ensure marking is started but it is recommended to always use this command.

C = 0x02 AAAA = unused, set to 0 BBBB = unused, set to 0 EEEE = unused, set to 0

```
Wait for external trigger
```

Set a trigger point to current position of stream; emission of output data will stop until an external trigger signal is detected C = 0x03

AAAA = unused, set to 0 BBBB = unused, set to 0 EEEE = unused, set to 0



Specify the speeds to be used during jump or mark movements (invoked by commands 0x00 and 0x01) C = 0x04

AAAA = jumpspeed in unit bits per microsecond BBBB = markspeed in unit bits per microsecond EEEE = unused, set to 0

Set laser delays Specify the delays to be used when laser is turned on or off C = 0x05 AAAA = laser on delay in unit microseconds and in range -10000000..10000000 BBBB = laser off delay in unit microseconds and in range 0..10000000 EEEE = unused, set to 0

Set scanner delays

Specify the delays to be used before and after mark and within a polygon C = 0x06 AAAA = jumpdelay in unit microseconds BBBB = markdelay in unit microseconds EEEE = in-polygondelay in unit microseconds Stop marking

Tries to halt, continue or stop current output depending on the chosen option

C = 0x07

AAAA = stop option:

0 - tries to stop operation as fast as possible and rejects all data that still may be enqueued for execution

1 - marking is stopped next time the laser is off but no vector data are flushed, card is still active 2 - controller continues processing at the point where halt occured (requires a previously called command 0x07 with stop option 1)

BBBB = unused, set to 0

EEEE = unused, set to 0

Set wobble parameters

Specify the wobble settings to be used for next marking operations

C = 0x08

AAAA = wobble amplitude in X-direction using unit bits and with maximum range of 0..10000000 bits BBBB = wobble amplitude in Y-direction using unit bits and with maximum range of 0..10000000 bits EEEE = wobble frequency in unit Hz*100 and in range 1..2500000

Set LP8 outputs

Set LPO..LP7 output pins on LP8 Extension Board C = 0x09 AAAA - bitpattern to be set on LPO..LP7 output pins, here only lower 8 bits are used. BBBB = unused, set to 0 EEEE = unused, set to 0

Ping

This command can be used to let the controller send back a state-information. So it can be used to check if the card is still operating or not.

ATTENTION: this command should not be sent repeatedly and without any delay! This could cause E1701D scanner controller to stall because the massive data transfer has to be handled. So it is recommended to have a delay of at least 150 msec between every ping.

C = 0x0A AAAA - unused, set to 0 BBBB = unused, set to 0 EEEE = unused, set to 0

Set digital outputs

Set DOut0..DOut7 output pins on Digi I/O Extension Board

C = 0x0B

AAAA - bitpattern to be set on DOut0..DOut7 output pins, here only lower 8 bits are used. BBBB = bitmask specifying which of the bits in AAAA have to be set or cleared, all these bits in AAAA are left unchanged, where the corresponding bit in BBBB is 0 EEEE = unused, set to 0

Set lasermode

Specify the laser mode the card has to operate with

C = 0x0C

AAAA - flags specifying the laser mode, here following values have to be or-concatenated to specify the behaviour of a laser:

- 0×40000000 laser frequency on LaserA output is turned on immediately and together with laser gate signal, this flag can't be used together with 0×20000000
- 0x20000000 laser frequency on LaserA output is turned on after FPK time, this flag can't be used together with 0x40000000

- 0x1000000 laser supports FPK on LaserB output
- 0x08000000 laser frequency has to be turned off and switched to standby-frequency
- 0x04000000 a frequency can be emitted at LaserB permanently, the related frequency can be specified with command 0x15;

this flag requires firmware version 19 or newer.

Using these flags following laser types can be configured:

- CO2-laser:
- 0x4000000 + 0x0800000
 YAG-laser with FPK: 0x4000000 + 0x0800000 + 0x1000000 or 0x2000000 + 0x0800000 + 0x1000000
 laser with continuously running frequency: 0x4000000

```
BBBB = unused, set to 0
```

EEEE = unused, set to 0

Set marking on-the-fly parameters

Specify the parameters used for marking on-the-fly applications C = 0x0D AAAA = marking on-the-fly resolution in X-direction in unit bits per encoder increment BBBB = marking on-the-fly resolution in Y-direction in unit bits per encoder increment EEEE = unused, set to 0

Set laser frequency

Specify the frequency the laser has to be operated with during marks, usage of these parameters depends on the lasermode specified with command 0x0C

C = 0x0E

AAAA = frequency in unit Hz and in range 25..20000000 Hz

BBBB = pulse-width in unit microseconds and in range 1..65530 usec

EEEE = unused, set to 0

Set laser standby frequency

Specify the frequency the laser has to be operated with during jumps, usage of these parameters depends on the lasermode specified with command 0x0C

C = 0x0F

AAAA = frequency in unit Hz and in range 25..20000000 Hz

- BBBB = pulse-width in unit microseconds and in range 1..65530 usec
- EEEE = unused, set to 0

Set first pulse killer

Specify the pulse width of the FPK signal when laser is turned on, usage of these parameters depends on the lasermode specified with command 0x0C

C = 0x11

AAAA = FPK pulse width in unit microseconds*100

BBBB = the time the laser frequency has to be started after beginning of FPK using unit microseconds*2, this value is used only when lasermode flag 0x20000000 is set EEEE = unused, set to 0

Switch MO-output Turns the MO-output of LP8 Extension Board on or off C = 0x12 AAAA = turn MO output on when equal 1, turn it off when 0 BBBB = unused, set to 0 EEEE = unused, set to 0 Release external trigger

When card is waiting for an external trigger this command can be sent to release this external trigger by software and to continue execution without the need to receive a real external signal C = 0x13AAAA = unused, set to 0 BBBB = unused, set to 0 EEEE = unused, set to 0

Wait for external input signal

Stop execution until a defined input bitpattern is detected at configurable input pins DIn0..DIn7 of Digi I/O Extension Board

C = 0x14

AAAA = a bitpattern specifying which signals LOW or HIGH have to be detected at digital input pins BBBB = a bitpattern specifying which of the digital input pins have to be watched for a signal, these bits that are set to 0 are ignored while these bits, that are set to 1 have to get the state specified in previous parameter in order to let operation of card continue

EEEE = unused, set to 0

Set LaserB frequency

Specify the frequency LaserB output has to emit; this function can only be used when operating using a laser mode with flag 0×04000000 set (see command 0x0C above).

This command requires firmware version 19 or newer.

C = 0x15

AAAA = frequency in unit Hz and in range 25..20000000 Hz

BBBB = pulse-width in unit microseconds and in range 1..65530 usec

EEEE = unused, set to 0

Wait until on-the-fly-increments have been elapsed

This command adds some special kind of delay to the application. It can be used only when marking onthe-fly is enabled (by setting the on-the-fly factors), and halts laser marking not for a given time but for a given distance. Marking is continued only when the given number of increments has elapsed. When no or not enough increments are counted by the controller, operation only can be stopped.

This command requires firmware version 27 or newer.

C = 0x16

AAAA = positive or negative number of increments to wait for until operation continues; here it depends on the used counting direction of the encoder if the given distance-value has to be positive or negative, when sign of the number and counting direction of the encoder do not fit to each other, the controller will halt at this position for a very long time

BBBB = unused, set to 0 EEEE = unused, set to 0

Insert a delay into the stream of data

This command adds a delay and lets the controller wait for the given time of ticks until the next command is executed. One tick is equal to 0,5 usec.

This command requires firmware version 39 or newer. C = 0x18

AAAA = number of ticks to wait for BBBB = unused, set to 0 EEEE = unused, set to 0

Switch LP8-Latch-output Turns the LP8-Latch-output of LP8 Extension Board on or off This command requires firmware version 39 or newer. C = 0x19 AAAA = turn Latch output on when equal to 1, turn it off when 0 BBBB = unused, set to 0 EEEE = unused, set to 0

Specify output for MIP-signal

Specify a single output pin of Digi I/O Extension Board to be used for "Mark in progress"-signal, this output pin will be HIGH as long as a marking operation is in progress. C = 0x2A AAAA = the number (not a bitpattern!) of the digital output pin to be used for MIP-signal (in range 0..7) BBBB = unused, set to 0 EEEE = unused, set to 0

Halt/continue current marking operation

Stops the current marking operation on very next appearance of a jump or continue a previously halted operation.

C = 0x2F AAAA = 1 to halt marking and 0 to continue a halted operation BBBB = unused, set to 0 EEEE = unused, set to 0

Specify output for WET-signal

Specify a single output pin of Digi I/O Extension Board to be used for "Wait External Trigger"-signal, this output pin will be HIGH as controller is waiting for an external trigger.

This command requires firmware version 21 or newer.

```
C = 0x33
```

AAAA = the number (not a bitpattern!) of the digital output pin to be used for WET-signal (in range 0..7) BBBB = unused, set to 0 EEEE = unused, set to 0

Set first row of 2x2 output matrix

Specify the elements m11 and m12 of a 2x2 output matrix which is applied to all coordinate values as soon as the second half is applied with command 0x41. This matrix can be used to scale, slant, rotate and mirror the input coordinates in respect to the output positions. For details please check out description of command 0x41 below

This command requires firmware version 31 or newer.

C=0x40

AAAA = the m11 part of the 2x2 matrix multiplied with 1000000 BBBB = the m12 part of the 2x2 matrix multiplied with 1000000 EEEE = unused, set to 0

Set second row of 2x2 output matrix

Specify the elements m21 and m22 of a 2x2 output matrix which is applied to all coordinate values together with the first row of matrix data which has to be set using command 0x40 in a preceding call. This matrix can be used to scale, slant, rotate and mirror the input coordinates in respect to the output positions. Assumed a matrix bases on an 4-elements array, it has following structure:

{m11, m12, m21, m22}

then these matrix values can be used and even combined with each other by multiplying them:

- rotation: {cos(angle), -sin(angle), sin(angle), cos(angle)}
- scaling: {factorX, 0.0, 0.0, factorY}
- slant X: {1.0, 1.0/tan(angle), 0.0, 1.0}
- slant Y: {1.0, 0.0, 1.0/tan(angle), 1.0}
- mirror X: {-1.0, 0.0, 0.0, 1.0}
- mirror Y: {1.0, 0.0, 0.0, -1.0}

This command requires firmware version 31 or newer. C=0x41 AAAA = the m21 part of the 2x2 matrix multiplied with 1000000 BBBB = the m22 part of the 2x2 matrix multiplied with 1000000 EEEE = unused, set to 0

Download new firmware

Download a new firmware file to the controller and write it to the microSD-card so that it can be used after next reboot. The binary data of the new firmware have to be appended directly to this command. This command has to be used in a specific sequence in order to ensure the current firmware file is updated correctly:

- ensure the card is idle (state-flag SSSS is 0)
- send command 0x45 with length of firmware data and checksum
- send binary firmware data directly after this command
- wait until card state returns "active" (by repeatedly sending ping-commands), now in state flag SSSS bit 0x4000 (E170X CSTATE WRITING DATA) is set
- wait until card state returns "idle" again (by repeatedly sending ping-commands), the flag 0x4000 no longer should be set in state flag SSSS
- check if an error occurred: when flags 0x8000 (E170X_CSTATE_WRITING_DATA_ERROR) is set in state flag SSSS, downloading or writing or checksum calculation failed and the original file was not replaced; for debugging in such a case the command "cglog" can be called repeatedly until the related error text was found; when this error flag is set it can be reset only by using command 0x45 again
- reboot the controller
- check if the version of the firmware has changed
- This command requires firmware 32 or newer.

C = 0x45

AAAA = the length of the firmware file in bytes

BBBB = checksum for verification of the downloaded data, only when this checksum is correct, the old firmware file will be replaced; the checksum can be calculated using following function (C example code):

EEEE = specifies the file which has to be overwritten by the current data download:

- 0 overwrite file 0:/version.txt when downloading of data was successful
- 1 overwrite file 0:/e1701.fwi when downloading of data was successful
- 2 overwrite file 0:/e1701.dat when downloading of data was successful
- 3 overwrite file 0:/e1701.cfg when downloading of data was successful

Set Position Offset

Set a positive or negative offset which then applies to all following position commands submitted via command 0x00 or 0x01.

This offset is used until the controller is rebooted or until an other offset is set

This command requires firmware version 37 or newer.

C = 0x4A

AAAA = x-position offset in range -33554432..33554432

BBBB = y-position offset in range -33554432...33554432

EEEE = z-position offset in range -33554432...33554432

Reset the board

This function performs a warm reboot of the hardware and restarts the firmware. Reboot is done immediately, means this command does not return anything but connection to the board will be interrupted as soon as it has been sent. This command requires firmware version 19 or newer.

C = 0xFFAAAA = unused, set to 0 BBBB = unused, set to 0

EEEE = unused, set to 0
9 Programming Interfaces

The e1701.dll / libe1701.so shared library provides an own programming interface that gives the possibility to access and control the E1701 scanner controller card.

Beside of that e1701inter.dll / libe1701inter.so come with some compatibility interfaces for different other scanner cards like Scanlab(tm) RTC4(tm) and SCAPS(tm) USC1/2. They can be used to access E1701 scanner card with existing software easily. To do that, the "e1701inter" shared library just has to be renamed to the library name of the original vendor (like RTC4DLL.DLL, libsIrtc4.so or sc_optic.dll). In order to operate E1701 card with different than the default settings, recompilation of code to be reused is necessary, here at the very beginning and before initialisation a call to E170X_set_connection() has to be added in order to specify the connection to the card. Beside of this none of the different programming interfaces should be mixed.

The e1701inter.dll / libe1701inter.so is no longer supported and therefore available only until software versions up to 7.8.

9.1 E1701 Easy Interface Functions

These functions belong to the native programming interface of E1701 scanner card and should be used preferential in order to get access to all features and full performance of the scanner card. Header files and additional data required for using this interface can be found online in our public GIT-repository at https://sourceforge.net/p/oapc/code/ci/master/tree/libe1701/. There at https://sourceforge.net/p/oapc/code/ci/master/tree/libe1701/. There at https://sourceforge.net/p/oapc/code/ci/master/tree/libe1701/. There at https://sourceforge.net/p/oapc/code/ci/master/tree/libe1701/. There at https://sourceforge.net/p/oapc/code/ci/master/tree/libe1701/. There at https://sourceforge.net/p/oapc/code/ci/master/tree/libe1701/libe1701 test/ also an example application can be found that demonstrates the usage of the API.

Functions of E1701 Easy Interface are either stream commands that are executed in the order they are called, or functions that are executed immediately.

The E1701 does NOT use the concept of two or more lists that have to be managed and switched by the calling application. Here all stream commands simply are sent to the card without the need to provide some additional management information. Output of data is started only when $E170X_execute()$ is called or when a card-internal threshold is exceeded. This card-internal triggered output of data can be held back only by calling function $E170X_set_trigger_point()$ as very first so that marking starts only after an external trigger signal was detected by the card. In this case it is necessary to watch the buffer fill level of the card to avoid a buffer-overrun by calling function $E170X_get_free_space()$.

E1701 Easy Interface uses unit "bits" as base for all units and parameters. Since E1701 card internally uses 26 bits resolution for a better accuracy and to minimize round off errors, all calculation is done with these 26 bits. So the working area always has a size of 26 x 26 bits equal to 67108864 x 67108864. Independent from real resolution and output of hardware all calculations have to be done within this 26 bit range.

E1701 Easy Interface provides following functions:

unsigned char E170X_set_connection(const char *address)

This function has to be called as very first. It is used to specify the IP address where the card is accessible at (in case of Ethernet connection) or the serial interface (in case of USB connection, "COMx" for Windows and "/dev/ttyACMx" for Linux where "x" is the number of its interface). By default IP 192.168.2.254 is used. This is the only function that has to be called in case of both, when compatibility functions and when E1701 Easy Interface functions are used.

It returns a board instance number that has to be used with all following functions (this is true for Easy Interface and RTC-compatible functions).

Please note: this function does only set the connection information, it does not yet open the connection to the controller! This happens on first call to $E170X_load_correction()$.

Parameters:

address - a char-array containing the IP in xxx.yyy.zzz.aaa notation or the name of the COM port to be used

void E170X_set_password(const char n,const char *ethPwd)

Sets a password that is used for Ethernet connection of E1701 card. The same password has to be configured on E1701 configuration file e1701.cfg with parameter "passwd" to add an additional level of security to an Ethernet controlled card.

PLEASE NOTE: usage of this password does NOT provide enough security to control the card via networks that are accessible by a larger audience, publicly or via Internet! Also when this password is set, the card always should operate in secured, separated networks only!

Every card and every connection should use an own, unique password that can consist of up to 48 characters containing numbers, lower- and uppercase letters and punctuation marks. Due to compatibility reasons no language-specific special character should be used.

When connected via USB serial interface, this password is ignored. In this case no authentication is done.

Parameters:

ethPwd - the password to be used to authorise at an E1701 card. To reset a local password for connecting to a card that doesn't has a Ethernet password configured, hand over an empty string "" here

int E170X_load_correction(unsigned char n, const char* filename, unsigned char tableNum)

Loads a correction file to be used during vector data output. In case a previously loaded correction table has to be flushed and no other correction has to be used, parameter "filename" needs to be empty. This function has to be called for first time on initialisation and before any vector data are sent to the board. It is mandatory to call this function at least once since it establishes connection to E1701 card. So when no correction file has to be used, this function still has to be called but with an empty filename "".

This function supports different correction table file formats directly and without previous conversion:

- BeamConstruct .bco high resolution files
- Scanlab .ctb and .ct5 files
- SCAPS .ucf files
- Raylase .gcd files
- Rofin .fcr files
- CTI/GSI .xml files
- Sunny .txt 5x5 point correction files
- Han's .crt files

This is not a stream-command, means its data may be applied immediately and independent from current stream state.

Parameters:

n - the 1-based board instance number as returned by E170X set connection()

filename - the full path to the correction file to be loaded from file system, when "" is specified here, a previously used correction file is flushed and no/neutral correction is used as long as no other correction table is given

tableNum - the O-based correction table number these data have to be loaded for; it is possible to download up to 16 different correction tables and to switch between them during operation using function E170X_switch_correction()

Return: E170X OK or an E170X ERROR - or RTC-compatible return code in case of an error

void E170X_close(const unsigned char n)

Closes the connection to a card and releases all related resources. After this function was called, no more commands can be sent to the card until E170X set connection () and

E170X_load_correction()/n_load_correction_file()/load_correction_file()/ ScSCIInitInterface() is called again.

int E170X_switch_correction(unsigned char n, unsigned char tableNum)

Switches between up to 16 correction tables on the fly. When a table-number is given where no file was downloaded before using function E170X_load_correction(), no correction is performed on all following vector data.

This is a stream-command, means the new correction is applied to vector data sent to the card after this command but NOT to already sent but not yet processed data. Thus on-the-fly switching between correction tables is possible.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection()
tableNum - the 0-based table number of the correction that has to be used for all following vector data

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_debug_logfile(const unsigned char n,const char *path,const unsigned char flags)

This function can be used during development to check an own application regarding called commands and their parameters. It lets libe1701 write all function calls into a logfile so that it is possible to evaluate the real order of commands.

Parameters:

n – the 1-based board instance number as returned by ${\tt E170X_set_connection}$ ()

path - full path to the file which has to be used as debug log file

flags - a bunch of OR-concatenated flags which specify what function calls have to be written into or filtered from the log output; when 0x00 is specified here, the log file is kept quite small. When 0x01 is set, all motion-related function calls are added too, when 0x02 is set, all calls which check the state of the card are added to the log file.

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_xy_correction(const unsigned char n,const unsigned int flags,const double gainX, const double gainY,const double rot,const int offsetX,const int offsetY,const double slantX, const double slantY)

Sets size correction factor and offset for X and Y direction of working area as well as a rotation. With this command a matrix set with $E170X_set_matrix()$ will be overwritten.

This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands and changed values apply only to these vector data and coordinates, which are sent after calling this function.

Parameters:

n - the 1-based board instance number as returned by E170X set connection()

- flags following flags require firmware version 32 or newer:
 - E170X_COMMAND_FLAG_XYCORR_MIRRORX the output willbe mirrored in X-direction
 - E170X COMMAND FLAG XYCORR MIRRORY the output will be mirrored in Y-direction
- gainx scale factor in x-direction, 1.0 means no scaling

gainY - scale factor in y-direction, 1.0 means no scaling

rot - rotation of whole working area in unit degrees

offsetX - offset in x-direction in unit bits, 0 means no offset

offsetY - offset in y-direction in unit bits, O means no offset

slantX - trapezoidal correction along X-axis in range -45..45°
slantY - trapezoidal correction along Y-axis in range -45..45°

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_z_correction2(const unsigned char n,const int flags,const double gainZ,const int offsetZ,const unsigned int h,const double xy_to_z_ratio) Set additional Z correction parameters.

This function may be used to adjust the Z-axis and in cases where third axis is used with a large Z working range for an additional Z-focus-correction. Here additional deviation occurs when no F-Theta lens is used caused by the fact that the beam is always sent from the centre of the scanhead – which causes some kind of projection resulting in larger or smaller X and Y positions depending on the real Z height. This deviation can be adjusted by an internal Z-focus-correction.

Beside of that, the Z-position can be adjusted via a gain factor and by using an offset, shifting it into a specific direction

This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands and changed values apply only to these vector data and coordinates, which are sent after calling this function.

This function requires firmware version 27 or newer.

Parameters:

n - the 1-based board instance number as returned by <code>E1803_set_connection()</code>

flags - optionally set the flag E1803_COMMAND_FLAG_ZCORR_MIRRORZ to invert the orientation of the Z-axis, for normal scanhead working in correct direction, this value can be left at 0

gainZ - scales the Z axis by the given factor, when set to 1.0, no scaling is applied to the Z-coordinates offsetZ - shifts the Z-position into the given direction (using unit bits), when set to 0, no offset is applied to the Z-coordinates

h – the vertical height from last mirror of the scanhead to the working area (Z-position 0 of working area) in unit bits, when set to 0, the Z-focus-correction is disabled

 $xy_to_z_ratio - factor specifying the ratio between maximal horizontal working area size and maximal vertical movement size. As an example: when the working area has a size of 100 x 100 mm and the Z-axis has a maximum movement range of -20 mm .. 20 mm, the ratio to be set is 2,5 (100 mm horizontal divided by 40 mm vertical); when this value is set to a ratio equal or smaller than 0.0, the Z-focus-correction is disabled$

For more details about the Z-focus correction applied by setting the parameters h and $xy_to_z_ratio$, please refer to the image below:



Here "h" is the height from the position where the beam hits the last mirror to the position of the working area at z=0 position (in unit bits). "xy" is the width of the working area to be used together with the "z" range from "z=min" to "z=max" to calculate the $xy_to_z_ratio$. All working area parameters like its width "xy" and the "z"-range are expected to be the theoretical maximum of the full range, not the – possibly smaller – range used in a specific setup.

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_set_speeds(unsigned char n, double jumpspeed,double markspeed)

Set scanner speed values to be used for all following vector data and until not replaced by other speed values.

This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands and changed values apply only to these vector data and coordinates, which are sent after calling this function.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection()

jumpspeed - scanner movement speed during jumps (movements when laser is off) in unit bits/msec and range 1..4294960000

markspeed - scanner speed during mark (movements when laser is on) in unit bits/msec and range 1..4294960000

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_set_overspeed(const unsigned char n,const unsigned int flags,const double scannerLag,const double jumpFactor,const double reserved);

Turns on the overspeed function of the controller card which tries to move the scanhead with a multiple of its nominal speed without damaging the marking result by massive distortions. This function call can be used to enable and configure or to disable the overspeed-feature. Depending on the type of marking data this function can save nameable amounts of marking time. It can be used with any kind of scanhead which meet the following requirements:

hardware is a galvo-driven scanhead

is does not contain an internal speed limit that suppresses all speeds beyond an artificial limit

From technical point of view as soon as the overspeed function is enabled, all vector data are analysed by the controller card. When vectors are found which are suitable to be driven with overspeed, specific acceleration and deceleration ramps are done with these vectors to ensure the marking result itself is not distorted. Next these vectors are driven with a multiple of its normal speed. Vectors which are not suitable to be used with the overspeed function are left untouched, there neither any speed ramping is done nor is the nominal speed changed.

This function requires firmware version 41 or newer.

Parameters:

n - the 1-based board instance number as returned by E170X set connection ()

flags - a set of operational flags that specify how the function has to be used, currently only

E170X COMMAND FLAG STREAM is allowed

scannerLag – the lag ("tracking error") of the scanner in unit msec; this value is predefined by the hardware of the scanhead and should be available from its technical data; when this value is equal or less than 0.0, the overspeed-function is turned off

 $jumpFactor - the factor the nominal jump speed (as set via function E170X_set_speeds ()) is allowed to be exceeded during overspeed-drives; when this value is equal or less than 1.0, the overspeed-function is turned off$

 ${\tt reserved}$ – reserved for future use, has to be set to 0

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_set_laser_delays(const unsigned char n,double ondelay,double offdelay)

Set laser delay values to be used for all following vector data and until not replaced by other delay values.

This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands and changed values apply only to these vector data and coordinates, which are sent after calling this function.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection() ondelay - laser on delay in unit microseconds, can be a negative or a positive value offdelay - laser off delay in unit microseconds, must be a positive value



Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_scanner_delays(const unsigned char n,const unsigned int flags,const double jumpdelay,const double markdelay,const double polydelay)

Set scanner delays in unit microseconds. Smallest possible value and resolution is 0.5 microseconds. This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands. So values set here apply only to these vector data that are sent after this command.

Parameters:

n – the 1-based board instance number as returned by <code>E170X_set_connection()</code>

flags - here some flags can be set which add some further functional specifications and features to this function. At the moment following flags are supported and can be OR-concatenated with each other:

- E170X_COMMAND_FLAG_SCANNER_VAR_POLYDELAY when this flag is set, the value set via polydelay is not applied statically to every point within a polygon, but it is set dynamically depending on the angle between two lines; no angle (a straight line) results in no delay while a 180 degree angle results in a full delay as set by value polydelay; this flag requires firmware version 31 or newer
- jumpdelay the jump delay value in unit microseconds
- markdelay the mark delay value in unit microseconds
- polydelay the in-polygon delay value in unit microseconds

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_set_laser_mode(unsigned char n, unsigned int mode)

Sets the laser mode to be used for all following operations, this value influences the signals emitted at the connectors of the card. This function has to be called prior to setting any other laser parameters (like frequency, standby-frequency, power).

This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.

Parameters:

n – the 1-based board instance number as returned by <code>E170X_set_connection()</code> mode - the laser mode, here one of the following values is possible:

- E170X_LASERMODE_CO2 for controlling CO2 lasers, this mode supports stand-by frequency at LaserA output (to be set with function E170X_set_standby()) and PWM-modulated frequencies during marking and for power control (to be set with function E170X set laser timing())
- E170X_LASERMODE_YAG1 for controlling YAG lasers, this mode supports stand-by and Q-Switch frequency at LaserA output (to be set with function E170X_set_standby()) and a first pulse killer signal at output LaserB that is issued on beginning of a mark together with the Q-Switch frequency (to be set with function E170X_set_fpk()):



Here Q-Switch signal is started together with laser gate and FPK pulse. At end of mark when laser gate is turned off stand-by frequency is emitted at LaserA.

E170X_LASERMODE_YAG2 - for controlling YAG lasers, this mode supports stand-by and Q-Switch frequency at LaserA output (to be set with function E170X_set_standby()) and a first pulse killer signal at output LaserB that is issued on beginning followed by Q-Switch frequency that starts when FPK pulse has finished:



Here FPK and laser gate are started together. Q-Switch signal is started at end of FPK pulse. At end of mark when laser gate is turned off, stand-by frequency and pulse-width is emitted at LaserA instead of Q-Switch frequency.

E170X_LASERMODE_YAG3 - for controlling YAG lasers, this mode supports stand-by and Q-Switch frequency at LaserA output (to be set with function E170X_set_standby()) and a first pulse killer signal at output LaserB that is issued on beginning followed by Q-Switch frequency that starts after a freely configurable time period "yag3QTime":



Here FPK and laser gate are started together. Q-Switch signal is started after yag3QTime has elapsed according to the beginning of FPK pulse. This time value can be set using function $E170X_set_fpk()$. At end of mark when laser gate is turned off, stand-by frequency and pulse-width is emitted at LaserA instead of Q-Switch frequency.

- E170X_LASERMODE_CRF for controlling lasers that require a continuously running frequency (like fiber-lasers), this frequency is emitted at LaserA output and can be set and changed by calling function E170X_set_standby().
- E170X_LASERMODE_DFREQ for controlling special lasers that require two frequencies, the second, continuously running frequency is emitted at LaserB output and can be set with function E170X_set_laserb()
- E170X_LASERMODE_MOPA for fiber lasers which are driven by a main oscillator and power amplifier and that are power-controlled via LP8 digital port and latch bit

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_set_laser(const unsigned char n,const unsigned int flags,const char on)

Switches the laser on or off independent fro many mark or jump commands.

Parameters:

n – the 1-based board instance number as returned by <code>E170X_set_connection()</code>

<code>flags - handling flags specifying the behaviour of this command, E170X_COMMAND_FLAG_STREAM to use it as stream command, E170X_COMMAND_FLAG_DIRECT to execute it immediately and independent on current stream and execution state; in case E170X_COMMAND_FLAG_STREAM is used, please ensure this function call is followed by other stream commands, elsewhere the laser is turned off for security reasons as soon as no more data are available to process in order to not to let the laser fire while the card is waiting on – set to 1 to turn the laser on or to 0 to turn it off</code>

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_set_wobble(const unsigned char n, unsigned int x, unsigned int y, double freq)

This function gives the possibility to not to let the laser beam follow the given path directly but to rotate around the specified path and lasers current position. Depending on chosen wobble-parameters and marking speed, this results either in a thick or a sinusoidal line. This call sets wobble parameters to be used for all following vector data and until not replaced by other wobble values or by 0 which disables wobble mode. This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.

Parameters:

- n the 1-based board instance number as returned by $\texttt{E170X_set_connection}$ ()
- $\rm x$ wobble amplitude in x direction in units bits and range 1..10000000
- ${\rm y}$ wobble amplitude in y direction in units bits and range 1..10000000
- freq wobble frequency in Hz in range 1..25000

int E170X_jump_abs(const unsigned char n,int x,int y,int z)

Perform a jump (movement with laser turned off) to the given position. This causes a galvo movement from current position to the one specified by this functions parameters using the jump speed and taking the jump delay into account:



When laser was turned on before this function is called, laser is turned off at the beginning with a delay specified by laser off delay (please refer to description of $E170X_mark_abs$ () for a diagram showing laser off delay too).

This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.

Parameters:

n – the 1-based board instance number as returned by $\texttt{E170X_set_connection}$ ()

 ${\rm x}$ – the x-coordinate in unit bits the scanner has to jump to

 ${\rm y}$ – the y-coordinate in unit bits the scanner has to jump to

 $\rm z\,$ – the z-coordinate in unit bits the scanner has to jump to (requires a hardware that is equipped with Z-channel)

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_mark_abs(const unsigned char n,int x,int y,int z)

Perform a mark (movement with laser turned on) to the given position. This causes a galvo movement from current position to the one specified by this functions parameters using the mark speed and taking the mark delay into account. When laser was turned off before this function is called, laser is turned on at the beginning with a delay specified by laser on delay:



This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.

Parameters:

n - the 1-based board instance number as returned by E170X set connection()

x - the x-coordinate in unit bits the scanner has to move to

y - the y-coordinate in unit bits the scanner has to move to

 $\rm z\,$ – the z-coordinate in unit bits the scanner has to move to (requires a hardware that is equipped with Z-channel)

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_get_pos(const unsigned char n,int *x,int *y,int *z)

This function returns the last position of the scanner:

• when an XY3-100 scanhead is connected, that provides its actual position, these values are returned

• when no such scanhead is connected, the last nominal position sent to the head are returned

The function needs the controller to be in idle-mode, means no marking operation is allowed to run in order to get the position information.

Please note: when a correction file is set, and/or a matrix is set and/or an offset is set and/or any other function is used which modifies the position data, the coordinates returned here are **not** the values which have been sent with the last call to $E170X_jump_abs()$ or $E170X_mark_abs()$ or $E170X_set_pos()$ as they have been processed and modified by these correction functions. So while the jump/mark functions set position data according to the desired coordinate system, the values returned by $E170X_get_abs()$ are the real-world coordinates at the hardware.

This function requires firmware version 42 or newer.

Return: E170X OK or an E170X ERROR -return code in case of an error

HANDLE WITH CARE! This function causes galvo movement to the given position immediately, without respect to any mark or jump speed values, without micro-vectorisation or intermediate steps! This means it can result in a very heavy movement for the galvos and in worst case it may cause some damage! Since the resulting movement speed may be way too high for the used galvos, they may overshoot and need some time until the desired position is reached. So this function is mainly intended to be used for <u>very</u> small position changes in respect to the galvos current position.

This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.

Parameters:

n – the 1-based board instance number as returned by $\texttt{E170X_set_connection}$ ()

 ${\rm x}$ – the x-coordinate in unit bits the scanner has to jump to

 ${\ensuremath{{}_{\rm Y}}}$ – the y-coordinate in unit bits the scanner has to jump to

 $\rm z\,$ – the z-coordinate in unit bits the scanner has to jump to (requires a hardware that is equipped with Z-channel)

laserOn - specifies if the movement has to be done with laser turned on (1) or off (0)

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_set_pixelmode(const unsigned char n,const unsigned int mode,const double powerThres,const unsigned int res)

Set the operational mode for $E170X_mark_pixelline()$. This function influences the behaviour when marking a pixel line. This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.

This function requires firmware version 19 or newer.

Parameters:

n – the 1-based board instance number as returned by $\texttt{E170X_set_connection}$ () mode – pixel marking mode, this parameter can be set to:

- 0 default mode, while marking a pixel line the controller tries to perform jumps when power is below of the given threshold powerThres to save marking time
- E170X_PIXELMODE_NO_JUMPS no jumps are performed, the given power threshold is ignored and the full pixel line is done with marking speed; this mode is slower but can result in more accurate and more exact images
- E170X_PIXELMODE_JUMP_N_SHOOT marking of the line is no longer done with a continuous movement but with a sequence "jump to position → shoot → jump to next position → shoot → jump to next position → shoot..."; here the shoot-time is equal to the laser-off-delay minus laser-on-delay as set with function E170X_set_laser_delays()
- E170X_PIXELMODE_HW_POWER_CONTROL when this flag is set, the controller card takes care about setting the power for the pixels. This works only when a lasermode is chosen where the scanner card supports native power control. When this flag is set, a power-callback, handed over together with a call to E170X_mark_pixelline() is ignored.
- E170X_PIXELMODE_GATE_POWER_CONTROL this is a special bitmap marking mode where no real power control is supported. When this flag is set, the LaserGate output is toggled depending on the required output power. Since this output supports only states LOW and HIGH, this bitmap marking mode results in black and white images only
- E170X_PIXELMODE_JUMP_LEAVE_POWER during bitmap marking, when no flag E170X_PIXELMODE_NO_JUMPS is set, below of a specific power threshold a jump is performed. By default, prior to such a jump, the laser power is set to 0 to handle faultily lasers that have spurious emissions even when LaserGate is at LOW. For laser types, which do not suffer from such emissions, this flag can be set. It leaves the last power value active also during jumps, which saves some marking time. So this flag can be used for speed-optimising bitmapmarking.

powerThres – this value is used only in default mode, when the marking power for some pixels is below of the given value (in unit percent), a jump is performed to save marking time, during this jump the laser is off and no marking is done

 ${\tt res}$ – reserved, set always to 0

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_mark_pixelline(const unsigned char n,int x,int y,int z,int pixWidth,int pixHeight,int pixDepth,unsigned int pixNum,double *pixels,E170X_power_callback power_callback,void *userData)

This function can be used to mark a single line of a bitmap image. Here horizontal, vertical and even 3D bitmap lines (going into depth) can be marked. Direction and orientation of the line to be marked can be chosen freely. A full image can be created by concatenating several lines. Power control during marking of such a bitmap line is not limited to some specific power outputs, it can be fully customised via a callback function.

Parameters:

 $\rm n$ – the 1-based board instance number as returned by E170X_set_connection()

x, y, z - the starting coordinates of the line in unit bits

pixWidth - the width of a single pixel (in unit bits), when this is set to a value greater or smaller than 0 while all the others are equal 0, a horizontal line is drawn; the sign of the value specifies the marking direction pixHeight - the height of a single pixel (in unit bits), when this is set to a value greater or smaller than 0 while all the others are equal 0, a vertical line is drawn; the sign of the value specifies the marking direction pixDepth - the depth of a single pixel (in unit bits, requires a 3D-capable scanhead), when this is set to a value greater or smaller than 0 while all the others are equal 0, line goes into depth; the sign of the value specifies the marking direction

pixNum - the number of pixel data contained in the array of intensity values handed over with the following parameter

<code>pixels</code> – an array of double-values with a length equal the number of pixels specified with <code>pixNum</code> and with an allowed range of 0.0..100.0 specifying the intensity; every entry of this array is equal to one pixel of the bitmap, so a greyscale-pixelline with brightness values in range 0..255 has to be converted to values in range 0.0..100.0

power_callback - this is a callback function of type

int (*E170X_power_callback) (unsigned char n, double power, void *userData)

which is used to set the power for every pixel. There these E170X_-functions have to be called that belong to the used laser type and set the power values according to it's hardware capabilities. Within the power callback function only stream commands are allowed to be called. It is not possible to use external devices that are not synchronous to E1701 command stream. The power callback has to return with $E170X_OK$ when setting of power was successful. In case of an error the appropriate error code has to be returned, the pixel marking function will be cancelled in such a case too and does not finish marking of the line. Parameter n is the 1-based board instance number specifying the board the power has to be changed for, power is the power to be set in unit percent and userData are some free to use, custom data that can be handed over on call to E170X mark pixelline().

userData - here some custom data can be handed over which are forwarded on and handed over at every call of the power-callback

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_matrix(const unsigned char n,const unsigned int flags,const double m11,const double m12,const double m21,const double m22)

Specify a 2x2 matrix that contains scaling and rotation corrections for the output. When a given matrix element parameter has a value smaller or equal -10000000 it is ignored and the previous/default value is kept at this position in matrix. With this command any correction set with $E170X_set_xy_correction2$ () will be overwritten.

This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.

Parameters:

n - the 1-based board instance number as returned by E170X set connection()

- flags reserved for future use, set to 0 for compatibility
- m11 first matrix element in first row

m12 - second matrix element in first row

m21 – first matrix element in second row

m22 - second matrix element in second row

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_trigger_point(const unsigned char n)

Specifies a point in data stream where execution has to stop until an external trigger signal (mark start) or a manual release of this trigger point is detected. This expects a rising edge on ExtStart input or calling of function E170X_release_trigger_point().

This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.

Parameters:

n - the 1-based board instance number as returned by E170X set connection()

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_release_trigger_point(const unsigned char n)

 $\label{eq:trigger_point()} This function should be called only when a call to {\tt E170X_set_trigger_point()} was done before. It acts like an external trigger signal, releases the waiting condition and lets the controller start processing. So this function provides some kind of software-simulated external start-signal.$

ATTENTION: this command will not arrive at the controller when there is no more space left on it, means when all controller-internal buffers are filled. So after a call to $E170X_set_trigger_point()$ and during sending of commands and data to the controller, application has to ensure there is some space left in controller's buffers. This can be done by calling $E170X_get_free_space()$ with flag $E170X_FREE_SPACE_PRIMARY$ for checking the available space in primary buffer. It is recommended to leave space for at least 10000 elements in primary buffer in order to let a call to $E170X_release_trigger_point()$ work properly. When the buffers already have been filled completely, this function will no longer work and marking can be started only by applying the ExtStart hardware signal.

This is not a stream-command, it is applied to controller immediately.

Parameters:

n - the 1-based board instance number as returned by E170X set connection()

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_signal_point(const unsigned char n,const unsigned int flags)

Specifies a point in data stream where execution has to stop until an external signal (mark start) is detected. Different to $E170X_set_trigger_point()$ this function does not expect a rising edge but a specific signal at the ExtStart input. The signal and the functions behaviour can be specified with the parameter flags which can consist of the following, OR-concatenated flags:

E170X_COMMAND_FLAG_HIGH_LEVEL - when this flag is set, the function waits for a HIGH-leven alt the ExtStart input, when it is not set, it waits for a LOW-signal

 $E170x_COMMAND_FLAG_SILENT - by default, every time the function waits for a specific level, causes a state$ $change by setting the state-flag <math>E170x_CSTATE_WAIT_EXTSIGNAL$ and by resetting it as soon as the required signal was detected. According to the workign principle of the controllers states, each of these state changes has to be fetched by a corresponding call to $E170x_get_card_state()$. Now when this function to wait for a signal is used very often, this can cause a load of state-changes being enqueued which can't be fetched by the calling application fast enough. In this situation (or whenever the waiting-state of the controller is not interesting to be known), the flag $E170x_COMMAND_FLAG_SILENT$ can be set. Then the function operates silently without any feedback via the controllers state.

This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.

Parameters: n - the 1-based board instance number as returned by E170X_set_connection() value - the signal level to wait for at ExtStart input, here 0 or 1 can be specified

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_set_sync(const unsigned char n,const unsigned int flags,const unsigned int value)

 $\label{eq:linear} This function sends a synchronisation value to the controller. As soon as marking reaches the related position in stream, the value returned by function E170X_get_sync() changes to the value given here. This command delays execution of the data by 0,5 usec, so it should not be used excessively. A value of 0xFFFFFFF disables this function.$

This function requires firmware version 30 or newer.

Parameters:

n - the 1-based board instance number as returned by E170X set connection()

flags - currently unused, set to 0 for future compatibility

value – the value to be used as sync-identifier, here on every call a different value should be handed over in order to differentiate what is returned by E170X get sync().

Return: E170X OK or an E170X ERROR -return code in case of an error

unsigned int E170X_get_sync(const unsigned char n)

Returns a sync-identifier as set by ${\tt E170X_set_sync}$ () as soon as the related position in stream was reached.

This function requires firmware version 30 or newer.

Parameters:

n - the 1-based board instance number as returned by <code>E170X_set_connection()</code>

Return: the last sync-identifier which was identified and processed in stream of commands or 0xFFFFFFF when function is not used/turned off

int E170X_execute(const unsigned char n)

Starts execution of all previously sent commands in case card is not already outputting these data. The E1701 Easy Programming Interface does not use the concept of two or more lists that have to be handled and switched by the calling application. Nevertheless the user has to ensure the card can start marking by calling this function after all vector data have been sent to the card. Here it does not matter if the card is already executing or not, subsequent calls to $E170X_execute()$ do not influence marking behaviour. More than this: in case very much data are sent to the card, it starts marking automatically after a defined fill level was reached. Due to this automated, fill level dependent start it would not be necessary to call $E170X_execute()$. But in situations where only very few data are sent to the card, it is necessary to call $E170X_execute()$. But in marking also in these cases where the internal fill threshold is not reached and where the card would not start marking immediately. Thus it is recommended to always call this function after all marking data have been sent. Marking is finished only when STOP (ExtStop signal input or $E170X_stop_execution()$) is invoked or when the internal buffer is empty. When internal buffer runs empty because subsequent data are not sent fast enough, an additional call to $E170X_execute()$ is necessary in order to output the remaining data. This is not a stream command since it controls the already sent stream of commands.

Parameters:

n – the 1-based board instance number as returned by <code>E170X_set_connection()</code>

int E170X_stop_execution(const unsigned char n)

Stops the currently running execution as fast as possible and drops all marking data that still may be queued. Calling this function also would drop all laser and scanner parameters that are already sent but not yet processed. Thus after calling this function it may be necessary to set scanner and laser parameters again in order to ensure they are used for following operations.

This is not a stream command since it controls the current stream of commands.

PLEASE NOTE: this function should not be called on the off-chance "to be sure nothing is running". The command works asynchronously and causes a state-change which can have some unwanted side-effects when it is used without a specific reason. So calling the function should be done only when the controller is really in state marking/running, and after calling it, no other functions have to be used until the state (E170X get card state()) has changed back to idle. As the stop is done as fast as possible, the point, at

what the stream is stopped, is undefined. Means any function that has been called between the last call to E170X_execute() and E170X_stop_execution() may not have an effect and probably needs to be repeated.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection()

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_halt_execution(const unsigned char n,const unsigned char halt)

Halts or continues the processing and output of marking data. On halt=1 marking is stopped next time the laser is off. Different to a full stop no vector data are flushed. On continue (halt=0) controller continues processing at the point where halt occurred. When marking is stopped with $E170X_stop_execution()$ the halt-condition is cleared too, means on next transmission of new marking data they are processed without the need to explicitly continue last operation. This command requires firmware version 16 or newer.

Parameters:

n – the 1-based board instance number as returned by $\texttt{E170X_set_connection()}$ halt – 1 to halt operation next time the laser is off, 0 to continue a previously halted operation

Return: E170X OK or an E170X ERROR -return code in case of an error

unsigned int E170X_get_startstop_state(const unsigned char n)

This function returns a bit pattern that informs about state of the start and stop input pins. This is not a stream command since it returns the current state immediately. Here "current state" means the last known state. When the state changes during this call, it may be possible the previous, no longer actual state is given back since transmission of data from controller to host is done asynchronously and independent from a call to this function.

Parameters:

n - the 1-based board instance number as returned by E170X set connection()

Return: a bit pattern specifying the current state:

- bit 0 and 1 (0x00000003) specify if the start input was set after last call of this function, when these bits are set, a rising edge has been detected at this input; calling this function resets the internal state of these bits, means when it is called again and when no new rising edge has been detected meanwhile, these bits will be 0
- bit 2 and 3 (0x000000C) specify if the stop input was set after last call of this function, when they are set, a rising edge has been detected at this input; calling this function resets the internal state of these

bits, means when it is called again and when no new rising edge has been detected at top input meanwhile, these bits will be low

 bit 12 (0x00001000) this bit signals the start input is low, as long as this bit is set no start input signal is detected

int E170X_get_card_state(const unsigned char n, unsigned int *value)

This function returns a bit pattern that informs about cards current operational state. Here "current state" means the last known state. When the state changes during this call, it may be possible the previous, no longer actual state is given back since transmission of data from controller to host is done asynchronously and independent from a call to this function.

The card-states are enqueued internally in order to not to lose a "busy"-state which may be available for a very short time only in case of very small and fast marking cycles. So every state change caused by the calling application results in on state change returned by this function. This means for every marking cycle the application has to wait for two state changes: first wait until this function signals "busy"

(E170X_CSTATE_PROCESSING|E170X_CSTATE_MARKING) next wait until this function signals "ready" (0). During transfer of vector data and scanner/laser parameters this function should be called as rarely as possible: every call of E170X_get_card_state() performs a full cycle of transmission and receiving of data to and from the controller. Dependent on the current transmission state this may result in submission of a small block of data which does not uses the full available bandwidth. On excessive use of this function this can slow down the whole transfer of data.

This is not a stream command since it returns the current state immediately.

Parameters:

n - the 1-based board instance number as returned by $E170X_set_connection()$

state - pointer to a variable where the card state has to be written to: a bit pattern of or-concatenated constants specifying the current state:

- E170X_CSTATE_MARKING card is currently marking
- E170X_CSTATE_PROCESSING card has received some data that are enqueued for marking
- E170X_CSTATE_WAS_START_PRESSED the ExtStart input was triggered, this flag is cleared after it has bean read and is set again only when ExtStart was triggered again
- E170X_CSTATE_WAS_STOP_PRESSED the ExtStop input was triggered, this flag is cleared after it has bean read and is set again only when ExtStop was triggered again
- E170X_CSTATE_FILE_WRITE_ERROR this flag is returned only in case stand-alone data are written to the microSD card and in case an file error occurs during this procedure. As writing an EPR file is done as asynchronous stream, errors during this procedure are not announced by the functions which are called but only by this error state. For more information about writing of stand alone data please refer to section "9.1.1 Writing of stand-alone data"
- E170X_CSTATE_WAIT_EXTTRIGGER the controller is in state "marking" but is not yet processing any data as it is waiting for an external trigger
- E170X_CSTATE_HALTED the controller is in state "marking" but is not yet processing any data as it is currently halted by function E170X halt execution()
- E170X_CSTATE_WAIT_INPUT the controller is in state "marking" but is not yet processing any data as it is waiting for a specific input pattern at the digital inputs
- E170X_CSTATE_SAC_READY this flag applies only to stand-alone modes; it is similar to output DOutO and signals the controller has loaded a stand-alone file and is ready for marking
- E170X_CSTATE_SAC_MARKING this flag applies only to stand-alone modes; it is similar to output DOut1 and signals the controller is marking a loaded EPR file
- E170X_CSTATE_SAC_CTLXY this flag applies only to stand-alone modes; it signals a "ctlxy" command was received and the related mode is active

When the function returns an error code instead of E170X_OK, this value is undefined and can't be used.

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_delay(const unsigned char n, double delay)

Pause marking for the given time.

This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection()
delay - time to wait until marking continues in unit usec, smallest possible value is 0,500 usecs

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_laser_timing(unsigned char n, double frequency, double pulse)

Set the frequency and pulse-width to be used during marking at LaserA output of LP8 Extension Board or Digital XY2-100 Baseboard.

This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection()
frequency - emitted frequency in unit Hz and in range 25..20000000 Hz
pulse - pulse width in usec, this value has to be smaller than period length that results out of frequency

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_standby(const unsigned char n,const double frequency,const double pulse, const bool force)

Set the frequency and pulse-width to be used during jumps, as stand-by frequency or as continuously running frequency at LaserA output of LP8 Extension Board or Digital XY2-100 Baseboard. This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.

Parameters:

n - the 1-based board instance number as returned by E170X set connection()

frequency – emitted frequency in unit Hz and in range 25..20000000 Hz. When a value of 0 is given, the frequency at LaserA output is turned off at end of mark.

pulse - pulse width in usec, this value has to be smaller than period length that results out of frequency
force - when set to true, the new stand-by frequency is not applied the next time the laser is turned off, but
immediately

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_laserb(const unsigned char n,const double frequency,const double pulse)

Set the frequency and pulse-width to be used at LaserB output of LP8 Extension Board or Digital XY2-100 Baseboard. To use LaserB as second frequency output, a laser mode with flag $E170X_LASERMODE_DFREQ$ has to be configured.

This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.

This function requires firmware version 19 or newer.

Parameters:

n – the 1-based board instance number as returned by $\texttt{E170X_set_connection}$ ()

 ${\tt frequency}$ - emitted frequency in unit Hz and in range 25..20000000 Hz

 ${\tt pulse}$ – pulse width in usec, this value has to be smaller than period length that results out of frequency

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_set_fpk(const unsigned char n, double fpk, double yag3QTime)

Set the parameters for first pulse killer signal that is emitted via LP8 Extension Board or Digital XY2-100 Baseboard whenever the laser is turned on; this applies to YAG-modes only and is emitted as one single pulse at LaserB output.

This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection()
fpk - the length of the first pulse killer signal in usec
yag3QTime - the length of the first pulse killer signal in usec, this value is used only when laser mode

E170X_LASERMODE_YAG3 is set, elsewhere it is ignored

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_get_free_space(const unsigned char n,int buffer)

This function returns the space (in unit "commands") that is free in one of the buffers of E1701. Here parameter buffer decides which buffer has to be checked.

Parameters:

n - the 1-based board instance number as returned by $\texttt{E170X_set_connection()}$ buffer - expects a constant which decides what buffer has to be checked, it has to be set to one of the following values:

• E170X_FREE_SPACE_PRIMARY - return size of the primary buffer; it can be used to avoid memory on host system is filled which may happen when vector data are sent to the controller while it's internal buffers are already full. In this case these data would have been stored on host side consuming some memory there. Using this function this problem can be avoided by sending commands only in case this function returns a value that is (much) larger than 0. The primary buffer that can be checked by using this value is one of two available buffers on E1701

controller. The primary one has a size of 900000 and is used to feed the secondary buffer (with a size of 17 million). So when this function returns 900000, this does not mean the buffer is empty and no vector data currently processed – they still may be stored in secondary buffer. So to check the operational state of the controller, only function E170X_get_card_state() can be used. This buffer has also to be checked when function E170X_release_trigger_point() is used in order to ensure the command can arrive at the controller. For a detailed description please refer to explanation of E170X_release_trigger_point() above.

E170X_FREE_SPACE_SECONDARY - return size of the secondary buffer; this one is filled by data from primary buffer and contains raw commands (like single micro vectors that concatenate to a full vector during output).

Return: -1 in case the function failed or the amount of free space in primary buffer.

void E170X_get_version(const unsigned char n, unsigned short *hwVersion, unsigned short *fwVersion)

Get the hardware and software version of the used board. It is recommended to call this function after successful connect always and check if used hardware and firmware version is at least a version that is known to work with own software.

This is not a stream command, it is executed immediately and independent from all other commands.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection()
hwVersion - pointer to a variable where the hardware revision/version number is written into

fwVersion - pointer to a variable where the revision/version number of the firmware running on the board is written into

const int E170X_get_library_version()

Returns an integer value which is an identifier specifying the version of this shared library. In decimal notation this identifier uses format "Mmmrrr" where "M" is the major version, "m" the minor version number and "r" the release count. The bigger the whole returned number is, the newer the library is.

int E170X_get_serial_number(const unsigned char n, char *serial, const int length)
Reads the serial number of the used board and returns it as 7 bit ASCII data.

This is not a stream command, it is executed immediately and independent from all other commands. This function requires a firmware version 39 or newer.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection() serial - pointer to a char-array where the serial number has to be stored into, this memory area needs to have a size of at least 40 bytes

 ${\tt length}$ – available length of the memory area where ${\tt serial}$ points to

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_lp8_write(const unsigned char n, unsigned int flags, unsigned char value)

Sets the LP8_0..LP8_7 outputs of 8 bit laser port of LP8 Extension Board without touching the related latch output. Total execution time of this command during processing on controller is 1 usec.

This function does not change the value at the analogue AOutO output of LP8 Extension Board. Depending on the value of parameter flags this is either a stream-command (means it is executed at a point in stream that is relative to the other stream commands) or a direct command (means it is executed immediately on calling). This command requires firmware version 16 or newer.

Parameters:

 $n - the 1-based board instance number as returned by E170X_set_connection()$

<code>flags - handling flags specifying the behaviour of this command, E170X_COMMAND_FLAG_STREAM to use it as stream command, E170X_COMMAND_FLAG_DIRECT to execute it immediately and independent on current stream and execution state</code>

value - the 8 bit value to be set at LP8 port

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_lp8_write_latch(const unsigned char n, unsigned char on, double delay1,unsigned char value, double delay2,double delay3)

Sets the LP8 8 bit laser port of LP8 Extension Board with freely definable delays and toggles the related latch output automatically; calling this function causes the following sequence of commands:

- turn latch bit on/off
- wait for delay1 usecs
- set LP8
- wait for delay2 usecs
- turn latch bit off/on
- wait for delay3 usecs

The whole execution time of this sequence on the controller is is 1.5 usecs for setting LP8 outputs and toggling latch plus delay1 plus delay2 plus delay3. Depending on the value of parameter "on" this function may or may not set the analogue AOut0 output successfully.

This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands.

Parameters:

n - the 1-based board instance number as returned by <code>E170X_set_connection()</code>

on – specifies if the latch bit has to be set to HIGH (on=1) or LOW (on=0) on first step, on second step it will toggle to value !=on

delay1 - delay to be issued after setting/clearing the latch bit for the first time

value - the 8 bit value to be set at LP8 port

delay2 - delay to be issued after setting LP8 output and before clearing/setting the latch bit

delay3 - delay to be issued after clearing/setting the latch bit for the second time

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_lp8_write_mo(const unsigned char n, const unsigned flags, const unsigned char on)

Sets the main oscillator output MO of LP8 Extension Board to be used with e.g. fiber lasers. Depending on the value of parameter flags this is either a stream-command (means it is executed at a point in stream that is relative to the other stream commands) or a direct command (means it is executed immediately on calling).

Parameters:

n – the 1-based board instance number as returned by $\texttt{E170X_set_connection}$ ()

<code>flags - handling flags specifying the behaviour of this command, E170X_COMMAND_FLAG_STREAM to use it as stream command, E170X_COMMAND_FLAG_DIRECT to execute it immediately and independent on current stream and execution state</code>

on – the state the MO output has to be switched to; PLEASE NOTE: the main oscillator depends on the current internal state of the laser. Thus turning it on is always possible but turning off the MO is possible only when the controller is not yet handling the laser-off delay, means it is not possible as long as the laser is turned on. In such a case this command is ignored.

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_lp8_ana_write(const unsigned char n,const unsigned int flags,const unsigned short value)

Sets the analogue output AOut0 of LP8 Extension Board. This also changes the state of LP8_0..LP8_7 outputs and toggles the LP8 latch. Total execution time of this command on the controller is 1 usec. Depending on the value of parameter flags this is either a stream-command (means it is executed at a point in stream that is relative to the other stream commands) or a direct command (means it is executed immediately on calling). Beside of that, for upwards compatibility reasons, it is always required to OR-concatenate the command flag with the additional flag $E170X_COMMAND_FLAG_ANA_AOUT0$ which specifies the analogue output to be used.

This command requires firmware version 16 or newer.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection() flags - handling flags specifying the behaviour of this command, E170X_COMMAND_FLAG_STREAM to use it

as stream command, E170X_COMMAND_FLAG_DIRECT to execute it immediately and independent on current stream and execution state

value - the 8 bit value to be set at analogue output port

Return: E170X_OK or an E170X_ERROR_return code in case of an error

int E170X_digi_write(const unsigned char n, unsigned int flags, unsigned int
value, unsigned int mask)

Sets the 8 bit digital output port of Digi I/O Extension Board.

Depending on the value of parameter flags this is either a stream-command (means it is executed at a point in stream that is relative to the other stream commands) or a direct command (means it is executed immediately on calling). This command requires firmware version 16 or newer. Parameters:

n - the 1-based board instance number as returned by E170X set connection()

flags - handling flags specifying the behaviour of this command, E170X_COMMAND_FLAG_STREAM to use it as stream command, E170X_COMMAND_FLAG_DIRECT to execute it immediately and independent on current stream and execution state

mask - specifies which of the bits in "value" have to be used for setting and clearing output data, only these bits that are set to 1 in mask are changed according to the given value

value - the 8 bit value to be set at digital out port

Return: E170X OK or an E170X ERROR return code in case of an error

int E170X_digi_pulse(const unsigned char n, const unsigned int flags, const unsigned int in_value, const unsigned int mask, const unsigned int pulses, const double delayOn, const double delayOff)

Send a sequence of pulses to the 8 bit digital output port of Digi I/O Extension Board. This command requires firmware version 16 or newer. When the controller works with a firmware version 32 or later, this operation causes nearly no data transmission load.

This command is available as stream-command only (means it is executed at a point in stream that is relative to the other stream commands).

Parameters:

n – the 1-based board instance number as returned by <code>E170X_set_connection()</code>

<code>flags - currently only E170X_COMMAND_FLAG_STREAM</code> is supported here

mask - specifies which of the bits in "value" have to be used for setting and clearing output data, only these bits that are set to 1 in mask are changed according to the given value

value - the 8 bit value to be set at digital out port

pulses - specifies how often the output has to be set/cleared

delayOn - the delay (in unit usec) which has to be issued every time after setting the output, the minimal resolution of this value is 0,5 usec

delayOff - the delay (in unit usec) which has to be issued every time after clearing the output, the minimal resolution of this value is 0,5 usec

Return: E170X_OK or an E170X_ERROR_return code in case of an error

int E170X_digi_read(const unsigned char n,const unsigned char flags,unsigned int *value)

Reads the 8 bit digital input port of Digi IO Extension Board.

This is not a stream-command, means it is executed immediately and returns current known state of the digital inputs.

When parameter flags is set to 0, the state of the digital inputs is requested actively which results in a separate data transmission to the controller card. On excessive use of this command, that may slow down communication with the controller dramatically. Alternatively flags can be set to

 $E170X_COMMAND_FLAG_PASSIVE$ which does not cause such a request. Instead of this the last known state of the digital inputs is returned by this function based on the last regular feedback from the controller or based on the last call to this function with this passive-flag not set. So when this flags is used, the returned value may be several hundred milliseconds old.

When marking on the fly is enabled using function $E170x_digi_set_motf()$, digital inputs 0 and 1 and optionally also digital inputs 2 and 3 are used for MOTF-encoder and therefore not available as standard inputs. In this case state of these bits is undefined and does not reflect the current input state caused by the external encoder.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection() value - pointer to a variable where the current digital input state has to be written into. When the function returns an error code instead of E170X_OK, this value is undefined and can't be used.

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_digi_wait(const unsigned char n, unsigned long value, unsigned long mask)

Stop execution and output of data until the given bitpattern was detected at digital inputs of Digit I/O Extension board. Here parameter mask specifies which of the bits at the input have to be checked, they have to be set to 1. These bits within mask that need to be ignored have to be set to 0. Parameter value itself defines the states of the bits that has to be detected at the input to continue processing of data. All bits of value that correspond to bits of mask, that are 0, are ignored.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection()
value - the expected bitpattern at digital input
mask - specifies which of the input bits and value bits have to be used for comparison

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_digi_set_motf(const unsigned char n, double motfX, double motfY)

Disables or enables marking on-the-fly functionality and specifies factors for X- and Y-direction. When this function is called with values for motfX or motfY greather than 0, marking on-the-fly is enabled and digital inputs 0 and 1 of DigilO Extension Board are no longer available as general purpose inputs. Now they are used as decoder inputs for a 90 degree phase shifted encoder signal for marking on-the-fly applications. When both parameters motfX and motfY are set to 0, marking on-the-fly is disabled and inputs 0 and 1 no longer work as encoder inputs.

When tune flag "2" is set (requires firmware 25 or higher), the two factors for X and Y are assigned to separate encoder inputs. Here factor for X applies to values received on digital inputs 0 and 1 and factor for Y applies to values received on digital inputs 2 and 3.

This is not a stream-command, means it switches states of digital inputs 0 and 1 (plus optionally 2 and 3) and marking on-the-fly functionality immediately.

Parameters:

n – the 1-based board instance number as returned by ${\tt E170X_set_connection}$ () ${\tt motfX}$ – marking on-the-fly factor for X-direction in unit bits per encoder increment

 $\verb"motfy-marking" on-the-fly factor for Y-direction" in unit bits per encoder increment$

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_digi_set_motf_sim(const unsigned char n, double motfX, double motfY)

Disables or enables simulated marking on-the-fly functionality and specifies factors for X- and Ydirection. When this function is called with values for motfX or motfY greather than 0, simulated marking onthe-fly is enabled and internal 100 kHz signal generator is used to create static marking on-the-fly pulses in positive direction. A possibly enabled on-the-fly operation using external signals on digital inputs 0 and 1 of Digi I/O Extension Board is disabled. When both parameters motfX and motfY are set to 0, marking on-the-fly simulation is disabled completely.

This is not a stream-command, means it enables simulated marking on-the-fly functionality immediately. Parameters:

n – the 1-based board instance number as returned by $\texttt{E170X_set_connection}$ ()

motfX - marking on-the-fly factor for X-direction in unit bits suitable for to be simulated movement-speed on 100 kHz encoder counting frequency

motfy - marking on-the-fly factor for Y-direction in unit bits suitable for to be simulated movement speed on 100 kHz encoder counting frequency

int E170X_digi_wait_motf(const unsigned char n, const unsigned int flags, const double dist)

Halts the current marking operation for a given distance of the on-the-fly encoder. Different to $E170x_delay()$ this function does not use a time to wait until marking is continued but a distance specified by parameter dist and measured by the connected encoder. To use this function marking on-the-fly has to be enabled by calling $E170x_digi_set_motf()$ or $E170x_digi_set_motf()$ before.

This command is useful for marking on-the-fly applications where several vector data have to be marked which in total are larger than the available working area of the scanhead (e.g. when marking long texts on a cable). For this the vector data to be marked have to be concatenated in suitable pieces where each piece is smaller than the available working area. Then these pieces can be marked consecutively with following sequence of commands:

- 1. E170X_set_trigger_point() (used only once at the very beginning to define the starting point and to initialise internal MOTF counters). This trigger point later has to be released either by applying an ExtStart signal or by calling function E170X_release_trigger_point()
- 2. E170X_digi_wait_motf() to wait for the beginning of the first piece of vector data to be marked, the given distance is equal to the distance from the starting point in 1)
- **3.** E170X_jump_abs()/E170X_mark_abs() for vector data of character to be marked; here one piece of the whole set of vector data has to be sent to the controller
- **4.** E170X_digi_wait_motf() to wait for the distance until next set of vector data; here the distance between the starting points of two pieces of vector data has to be given
- 5. continue at 3) until all pieces of vector data have been sent

This is a stream-command, means it is executed at a point in stream that is relative to the other stream commands. It requires firmware version 23 or newer.

Parameters:

n – the 1-based board instance number as returned by $E170X_set_connection()$

flags - specifies how the distance value is handed over, with E170X_COMMAND_FLAG_MOTF_WAIT_INCS a value in unit "encoder increments" is expected, with E170X_COMMAND_FLAG_MOTF_WAIT_BITS a distance in unit "bits" is expected. In second case the X-on-the-fly factor of a preceding call to E170X_digi_set_motf() or E170X_digi_set_motf sim() is used.

dist - the distance to wait for until marking has to be completed, the unit of this value is specified with preceding parameter flags

Return: E170X OK or an E170X ERROR -return code in case of an error

int E170X_digi_set_mip_output(const unsigned char n, unsigned int value, unsigned int flags)

This function can be used to specify which of the digital outputs has to be used for signalling "marking in progress". When value is set to 0xFFFFFFF and LaserB is configured as GPO, this output is used for signalling. When it is set to 0xFFFFFFO, this function is disabled and scanner controller card does not provide this signal automatically. When the number of the digital output (in range 0..7) is given as value, the related digital output pin is used for "mark in progress" signal.



During operation the selected "mark in progress" pin is HIGH as long as the scanner is moving and/or the laser is on and/or a delay is processed and when marking parameter are processed between these operations. It becomes LOW as soon as no more marking data are available and current operation is stopped or when scanner is waiting for an external trigger signal (ExtStart).

This is not a stream-commando, when it is called it is applied to current configuration immediately.

Parameters:

n – the 1-based board instance number as returned by $\texttt{E170X_set_connection}$ ()

value - the number of the digital output to be used for this signal

int E170X_digi_set_wet_output(const unsigned char n,const unsigned int value,const unsigned int flags)

This function can be used to specify which of the digital outputs has to be used for signalling "waiting for external trigger". When value is set to 0xFFFFFFF and LaserB is configured as GPO, this output is used for signalling. When it is set to 0xFFFFFFO, this function is disabled and scanner controller card does not provide this signal automatically. When the number of the digital output (in range 0..7) is given as value, the related digital output pin is used for "waiting for external trigger" signal.

PLEASE NOTE: here the number (means the count) of one specific output pin has to be given, not a bitpattern specifying one or more pins!

During operation the selected "waiting for external trigger" pin is HIGH as long as the controller is waiting for an external trigger to be applied at ExtStart input. It becomes LOW as soon as this signal has been detected or when current operation is stopped.

This is not a stream-command, when it is called, it is applied to current configuration immediately. This function requires firmware version 21 or newer.

Parameters:

n – the 1-based board instance number as returned by ${\tt E170X_set_connection}$ () value – the number of the digital output to be used for this signal

 ${\tt flags}$ – currently unused, set always to 0 for compatibility

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_write(const unsigned char n, unsigned int flags, unsigned int value)

Writes some specific data to outputs at E1701D controller. Here <code>flags</code> decides which output to use and <code>value</code> specifies what has to be written to this output. Additionally <code>flags</code> decides weather this is a stream-command (means it is executed at a point in stream that is relative to the other stream commands) or a direct command (means it is executed immediately on calling).

This command requires firmware version 17 or newer.

Parameters:

n – the 1-based board instance number as returned by $\texttt{E170X_set_connection()}$

flags - handling flags specifying the behaviour of this command, when E170X_COMMAND_FLAG_STREAM is set, it is used as stream command, E170X_COMMAND_FLAG_DIRECT specifies to execute it immediately and independent on current stream and execution state. Here exactly one of these two flags can be used, it is not allowed to OR-concatenate them. Additionally exactly one of the following flags has to be set to specify which output need to be used to send the value to, this flag has to be OR-concatenated with one of the previously described ones:

- E170X_COMMAND_FLAG_WRITE_LP8MO set or unset MO-output of LP8 Extension Board to a value of 1 or 0
- E170X_COMMAND_FLAG_WRITE_LP8LATCH set or unset latch-output of LP8 Extension Board to a value of 1 or 0
- E170X_COMMAND_FLAG_WRITE_LASERA_GPO set or unset LaserA-output to a value of 1 or 0, this option requires the LaserA output to be configured as GPO-output; for details please refer to description of "tune" parameters
- E170X_COMMAND_FLAG_WRITE_LASERB_GPO set or unset LaserB-output to a value of 1 or 0, this option requires the LaserB output to be configured as GPO-output; for details please refer to description of "tune" parameters
- E170x_COMMAND_FLAG_WRITE_LASERGATE set or unset LaserGate-output to a value of 1 or 0, this functions should be used with jump or mark operations only since every switch from jump to mark (or vice versa) still sets the LaserGate output automatically and therefore would overwrite own values set with this function

value - the value to be sent to the output specified by flags

int E1701_ana_a123(const unsigned char n,const unsigned short a1,const unsigned short a2,const unsigned short a3)

This function can be used to set the analogue outputs AOut1, AOut2 and AOut3 of the E1701A controller.

This is a stream-command, means its parameters are applied at a point in stream that is relative to the other stream commands.

Parameters:

n - the 1-based board instance number as returned by E170X_set_connection()

al – a 16 bit value specifying the output value at the AOut1 analogue output, independent from the real hardware resolution here always full 16 bit range has to be used

a2 – a 16 bit value specifying the output value at the AOut2 analogue output, independent from the real hardware resolution here always full 16 bit range has to be used

a3 – a 16 bit value specifying the output value at the AOut3 analogue output, independent from the real hardware resolution here always full 16 bit range has to be used

Return: E170X OK or an E170X ERROR -return code in case of an error

9.1.1 Writing of stand-alone data

Using E1701 Easy Programming Interface it is also possible to write stand-alone data which are not marked immediately but are stored either locally or on scanner controller's micro-SD-card. In this mode sending of vector data, scanner- and laser parameters looks exactly the same as for direct operation mode where data are marked immediately. The difference can be found in initialisation (which tells the software to not to mark these data but to store them for later use) and when dynamic data are created.

E1701 supports two types of writing of stand-alone data:

- sending them to the controller via Ethernet or USB connection where they are written to micro-SDcard and
- writing one or more files to the local file system which later have to be copied to the micro-SD-card of the controller manually.

The general procedure for sending stand-alone data to the controller's micro-SD-card has to look as follows:

- 1. The controller needs to be in idle-state, means it should not mark and should not have loaded an already existing .EPR file. This can be ensured by calling stand-alone command clepr with a filename for a file that does not exists on micro-SD-card. For more details please refer to "8.2 Stand-Alone Control Commands"
- 2. Configure the connection to E1701 controller by calling E170X_set_connection(), the returned board instance number has to be used for all following function calls.
- 3. Enable stand-alone write mode and specify the filename of the .EPR file to be created on micro-SD-card by calling E170X_set_filepath() with mode E170X_FILEMODE_SEND.
- 4. Send all laser- and scanner-parameters as well as vector data as usual.
- 5. Optionally: send information about dynamic contents of the .EPR file to be created by calling E170X_dynamic_data2() optionally followed by some vector data followed by an other call to function E170X_dynamic_data2() which ends this section of dynamic data (please refer function description below for details).
- 6. Wait until E170X_get_card_state() returns "busy"
- 7. Wait until E170X get card state () returns "idle" or an error
- 8. End data transmission and finish created file by calling $E170X_close()$.

The general procedure for writing stand-alone data to the local filesystem has to look as follows:

- 1. Since writing of local data does not require a working connection to the controller card, it does not need to be configured and the special board instance number 0 has to be used for all following function calls.
- 2. Enable stand-alone write mode and specify the filename of the .EPR file to be created by calling E170X_set_filepath() with mode E170X_FILEMODE_LOCAL.
- 3. Send all laser- and scanner-parameters as well as vector data as usual.
- 4. Optionally: send information about dynamic contents of the .EPR file to be created by calling E170X_dynamic_data2() optionally followed by some vector data followed by an other call to function E170X_dynamic_data2() which ends this section of dynamic data (please refer function description below for details).
- 5. End data transmission and finish created file by calling E170X close().

The functions which are specific to writing of stand-alone data have to be used as follows:

int E170X_set_filepath(const unsigned char n,const char *fname,unsigned int mode)

This function enables operation mode where all following data are not marked immediately but written into an .EPR stand-alone file. This mode stays active until next call of $E170X_close()$. It has to be called prior to $E170X_load_correction()$. Valid parameters and their meaning depends on the usage scenario:

• when sending stand-alone data to a connected controller which writes the .EPR file to the <u>micro-SD-card</u> directly:

n - the 1-based board instance number as returned by <code>E170X_set_connection() fname</code> - name of the file as it has to appear on micro-SD-card of the controller in style "0:/filename.epr" where "0:/" is a fixed prefix specifying the micro-SD-card, "filename" is a free to choose name with recommended 8 characters at max and ".epr" is a fixed, mandatory file extension specifying an E1701 stand-alone file

mode - set to E170X_FILEMODE_SEND to specify the data have to be sent to the controller

when writing stand-alone data to the <u>local filesystem</u> (no controller card directly involved):
 n - board instance number, has to be set to 0 (as well as for all other function calls in this mode)
 fname - name of the file to be written, this has to be a valid path to a location on a local filesystem
 which is writable and needs to have file extension ".epr"
 mode - set to E170X FILEMODE LOCAL to specify the data have to be written locally

Return: E170X_OK or an E170X_ERROR_-return code in case of an error

int E170X_dynamic_data2(const unsigned char n,struct oapc_bin_struct_dyn_data2 *dynData)

This function can be used to write dynamic data such as texts, serial numbers, barcodes which later can be changed during operation in stand-alone mode.

This function always has to be called in fixed sequences:

- 1. jump to the start position of the dynamic element by calling E170X_jump_abs()
- 2. first call of E170X_dynamic_data2 (n, dynData) with a valid dynData parameter describing the dynamic content and its capabilities
- 3. optionally and dependent on type of dynamic data that have to be created: some vector data which belong to the dynamic content and are required to build it up
- 4. second call of E170X_dynamic_data2 (n, NULL) with NULL handed over for parameter dynData to finish this element

A stand-alone file can contain up to ten dynamic data elements. So this function can be called up to ten times to create a new element on each call.

When this function is called, beside the .EPR-file an additional .DAT file is created which contains some specific data. During operation in stand-alone mode an other file with the same name and with extension .SER may be created which contains counting information of an included serial number. All these files belong together and deleting one or more of them may lead to unexpected results. When writing the data to local filesystem it also has to be ensured both, the .EPR and the .DAT fiel are copied to the controller later.

The structure <code>oapc_bin_struct_dyn_data2</code> is defined in file "oapc_libio.h" which is part of the OpenSDK. The general usage is described in OpenSDK manual, both are available for download at https://halaser.systems/download.php.

For E1701 scanner controller card following specific parameters and features of this structure can to be used:

Independent from what kind of dynamic element has to be created, following members of structure <code>oapc_bin_struct_dyn_data2</code> always have to be filled with data:

UID – and unique identifier which can be created out of a plain, human readable text which should be unique too and later can be used to access this specific element via stand-alone control commands; this identifier has to created out of the 8 bit ASCII character using following CRC-function: #define POLY 0x82f63b78

```
/* CRC-32 (Ethernet, ZIP, etc.) polynomial in reversed bit order. */
unsigned int crc32b(const char *buf)
{
   int
                k;
   unsigned int crc=0xFFFFFFF;
   size t
                len=strlen(buf);
   while (len--)
   {
      crc^=*buf++;
      for (k=0; k<8; k++)</pre>
       crc=crc&1 ? (crc>>1)^POLY : crc>>1;
   }
   return ~crc;
}
```

uScaleX - scaling factor in X-direction in unit 1/1000000 uScaleY - scaling factor in Y-direction in unit 1/1000000

```
res1a, res1b, res2, res3, res4, res5, res6, res7 - these members are reserved for later use and all have to be set to 0
```

Every dynamic element can be a serial number. In such a case the serial number part of structure <code>oapc_bin_struct_dyn_data2</code> has to be filled with data:

fmtString - an ASCII text with a maximum length of DYN_DATA_MAX_STRING_LENGTH describing the
 format of the serial number/date/time in the dynamic element, here the same notation has to be used
 as it is known from the serial number input element of BeamConstruct (please refer to the related
 manual)

snBeatCount - specifies how much numbers of mark operations have to elapse before the serial number has to be incremented, here a value of 1 has to be given to increment on every operation

```
snBeatOffset - specifies a counting offset for the beat count parameter
snIncrement - specifies the step width by which a serial number has to be incremented
snNumericBase - the numeric base of the serial numbers to be displayed, default is 10 for decimal numbers
snResetAtTime - the time value at which the serial number has to be reset to it's initial value; set to a
```

timestamp (in unit day of week/date/seconds) when it has to be reset at a given time <code>snResetAtValue</code> - the numeric value at which the serial number has to be reset to it's initial value

snFlags - a set of OR-concatenated flags which further specifies handling of the serial number:

- **0x0002 reset the serial number at a specific counting value specified by** snResetAtValue
- **0x0004 reset the serial number at a specific day of the week specified by** snResetAtTime

0x0008 - reset the serial number at a specific date specified by snResetAtTime

Ox0010 - reset the serial number at a specific time of the day specified by <code>snResetAtTime</code> <code>snStartValue</code> - the initial- and reset-to-value of the serial number

snMinDigits - the minimum number of digits the serial number has to consist of

```
timeOffset - a static offset (in unit seconds) to be added to the time-part of the current element
```

Dynamic text elements additionally need to fill following parts of the same structure oapc bin struct dyn data2:

- fmtString an ASCII text with a maximum length of DYN_DATA_MAX_STRING_LENGTH which contains the
 text to be shown and which can be changed by appropriate stand-alone commands later; when used in
 combination with serial number data, here a format-string has to be given as described above
- type a number which specifies the font to be used for creating the dynamic texts, here one of following values can be used:
 - 0x01000000 use "Rect Single" laser font
 - 0x02000000 use "Rect Double" laser font
 - 0x03000000 use "Roman Simple" laser font
 - 0x04000000 use "Roman Double" laser font
 - 0x05000000 use "Script Simple" laser font
 - 0x06000000 use "Script Double" laser font
 - 0x07000000 use "Script Complex" laser font
 - 0x08000000 use "Times Simple" laser font
 - 0x09000000 use "Times Bold" laser font
 - 0x0A000000 use "Times Italic" laser font
 - 0x0B000000 use "Times Italic Bold" laser font
- flags some OR-concatenated flags which specify orientation, alignment and style of the text to be generated, here no two flags of same type are allowed to be combined which would conflict with each other:
 - 0x0000000 orient text left to right
 - 0x00010000 orient text right to left
 - 0x00020000 orient text top to bottom
 - 0 ± 00030000 orient text bottom to top
 - 0x0000000 horizontally align to the left
 - 0x0000100 centre-align horizontally
 - 0x00000200 horizontally align to the right
 - 0x0000001 style fixed char-size all characters are forced to have same distance
- param1 kerning value in unit 1/1000%
- param2 reserved for future use, set to 0
- param3 spacing in unit 1/1000%

Dynamic DataMatrix barcode elements require vector data to be sent between two calls of function E170X_dynamic_data2(), these vector data describe the pattern which has to be marked to create one single element (means square) of the DataMatrix barcode. Such an element needs to incorporate all that is needed including laser- and scannerdata as well as vector data for outline and possible hatches. During standalone operation the barcode itself is created by combining these single elements at these positions, where a bit (=square) has to be set).

Additionally following data of the structure oapc_bin_struct_dyn_data2 need to be filled for this type of element:

- fmtString an ASCII text with a maximum length of DYN_DATA_MAX_STRING_LENGTH which contains the
 text to be encoded as DataMatrix barcode and which can be changed by appropriate stand-alone
 commands later; when used in combination with serial number data, here a format-string has to be
 given as described above
- type set to 71 for DataMatrix barcode
- flags some OR-concatenated flags which further specify how the barcode has to be created, currently only one flag is supported:

0x0001 - create a square-shaped DataMatrix barcode instead of a rectangular one

param1 – set to O

param2 - set to -1

param3 - specifies the size to be generated (in range 2..30) and implicitly the error correction level

quietZone - zone the barcode has to be surrounded with, the value given here is the multiple of the width of a single token multiplied with 1000

9.1.1.1 Example

Following a (simplified) example in some pseudo-code is given which demonstrates the correct usage of the programming interface to write stand-alone data. The laser- and scanner-parameters are dropped in this example since they are not specific to this operation mode and always have to be set.

Example: A serial number in format "000/hh/mm" where "000" is a continuously increased number, "hh" is the current hour and "mm" is the current minute has to be encoded into a DataMatrix barcode which has a size of 25x25 mm and is positioned at -30x30 mm within a 100x100 mm working area that itself is aligned to coordinates -50,50

- 1. not shown here: initialisation of libe1701 (with evaluation of parameter boardIdx), sending of default scanner and laser data as usual
- 2. E170X_jump_abs(boardIdx, -20132659, 20132659, 0) // jump to the starting position of the DataMatrix barcode to be created
- 3. E170X_dynamic_data2(boardIdx, dynData) // initiate the dynamic data sequence, here the members of dynData are set to following values:

UID	=	2340633892 – CRC-value of element name "Barcode 1"			
fmtString	=	" $S/$ %I/%M" – display serial number, hour and minute			
type	=	71 – DataMatrix barcode			
flags	=	1 – barcode forced to square			
param2	=	4294967295			
param3	=	2			
uScaleX	=	1029654			
uScaleY	=	1029654			
snIncrement	=	1			
snNumericBase	=	10			
snMinDigits	=	3			
all other values are	e se	t to 0			
E170X jump abs	5 (k	boardIdx, 0, 0, 0)			
E170X mark abs(boardIdx, 1197222, 0, 0)					
E170X mark abs(boardIdx, 1197222, -1197222, 0)					

E170X_mark_abs (boardIdx, 1197222, -1197222, 0) E170X_mark_abs (boardIdx, 0, -1197222, 0) E170X_mark_abs (boardIdx, 0, 0, 0) // draw a single rectangle which describes one DataMatrix cell (in this example only the outline without any hatching is done, hatches would have to be added here too

- 5. E170X dynamic data2 (boardIdx, NULL) // end the sequence of dynamic data
- 6. E170X execute (boardIdx)
- 7. Not shown here: waiting for card being busy, waiting for card being idle (which means writing of the Epr file to the microSd card has been finished), closing the connection to the controller

9.1.2 Error Codes

4.

Most of the functions described above can return an error code in case an operation could not be completed successfully for any reason. So when it does not return with $E170x_OK$ the error code informs about the reason for failure:

- E170X_ERROR_INVALID_CARD a wrong or illegal card number was specified with function parameter n
- E170X_ERROR_NO_CONNECTION a connection to card could not be established
- E170X_ERROR_NO_MEMORY there is not enough memory available on the host to perform the requested operation
- E170X ERROR UNKNOWN FW card is running an unknown and/or incompatible firmware version
- E170X ERROR TRANSMISSION data transmission to card failed

- E170X ERROR FILEOPEN opening of a file failed
- E170X_ERROR_FILEWRITE writing of data into a file failed
- E170X_ERROR_BORD_NA a base- or extension board that would be required for a function is not available
- E170X_ERROR_INVALID_DATA data or parameters handed over to a function are invalid, out of range or illegal in current context
- E170X_ERROR_UNKNOWN_BOARD trying to access a controller board that is not a suitable controller
- E170X_ERROR_FILENAME a file name handed over to a function was illegal, it is either too long, has an illegal or too long file extension, comes with too much sub-directories or contains illegal characters
- E170X_ERROR an other, unspecified error occurred
- E170X_ERROR_NOT_SUPPORTED the requested feature or function is not supported by the current firmware version
- E170X_ERROR_STILL_IN_PROGRESS the requested function could not be executed because the controller is still busy, this happens e.g. in cases where a stand-alone operation is running on the controller which is not under control of the programming interface

9.1.3 Compatibility

Prior to software version 7.3 all functions and definitions of the E1701 Easy Interface Functions made use of the prefix E1701. This prefix is still valid for all constants and functions but can be used for E1701 controller cards only.

For full compatibility with future versions of the E170X-series of scanner controller cards, please use the newer functions and defines that are marked with the E1701x prefix. These functions ensure full upwards-compatibility with new hardware versions and updated programming interfaces. So using these functions, porting an existing software to upcoming, newer hardware variants will be easier – and can be done in best case just by recompiling existing code against a new DLL/SO.

9.2 RTC4 Compatibility Functions

Beside the easy programming interface described above, prior to software version 8.0, a bunch of additional functions is provided that are compatible to the ones known from RTC4 scanner controller card. So to use E1701 scanner card with existing code that supports the RTC4 scanner controller, following few steps have to be done:

- insert a call to E170X_set_connection() into existing RTC4-code as very first in order to specify the communication connection for E1701 card (this is the only exception where an E1701 Easy Interface Function should be used together with an RTC Compatibility Function)
- recompile the existing RTC4-application so that it uses e1701inter.DLL/libe1701inter.so instead of RTC4DLL.dll/libslrtc4.so

In case E1701 card has to be operated with default settings, no recompilation is necessary, here e1701inter.dll / libe1701inter.so just has to be renamed to RTC4DLL.dll / libslrtc4.so.

Since most relevant RTC4 functions are already provided, majority of existing applications should work now without any further modifications. Due to the completely different concept of E1701 scanner controller, there are some differences to the original RTC4 programming interface which should be checked in case of some errors:

- all RTC4 functions that exist as list- and non-list-commands are treated like a list command
- list switch commands are ignored since E1701 does not make use of separated lists internally
- output of already sent marking data is started on calls to n_execute_list(), execute_list(), n set end of list() or set end of list()
- some functions are not implemented or always return a default value (please refer below for a list of not implemented RTC4 functions)

Following functions are specific to RTC4 hardware or do not make sense in relation to E1701 scanner card and therefore aren't supported. These functions exist in libe1701inter, but do not provide any functionality:

load z table() n set defocus list() set defocus list() n set offset list() set offset list() n laser on list() laser on list() n_set_list_jump() set_list_jump() n_set_input_pointer() set_input_pointer() n_list_call() list call() n list return() list_return() n_z_out_list() z_out_list() n_timed_jump_abs() timed_jump_abs() n timed mark abs() timed mark abs() n timed jump rel() timed jump rel() n timed mark rel() timed_mark_rel() n_set_fly_rot() set fly rot() n_fly_return() fly_return() n calculate fly() calculate fly() n_select_cor_table_list() select_cor_table_list() n set wait() set wait() n simulate ext start() simulate_ext_start() n_set_pixel_line() set_pixel_line() n_set_pixel() set pixel() n set extstartpos list() set extstartpos list() n laser signal on list() laser signal on list() n laser signal off list() laser signal off list() n set io cond list() set io cond list() n clear io cond list() clear io cond list() n list jump cond() list jump cond() n list call cond() list_call_cond() n save and restart timer() save and restart timer() n set ext start delay list() set_ext_start_delay_list() n_set_trigger() set_trigger() n_arc_rel() arc rel()

n arc abs() arc abs() drilling() regulation() flyline() n get input pointer() get input pointer() n_get_marking_info() get_marking_info() n_auto_change_pos() auto_change_pos() aut_change() n_start_loop() start_loop() n_quit_loop() quit_loop() n_write_da_2() write_da_2() n_set_max_counts() set max counts() n set offset() set offset() n disable laser() disable laser() n_enable_laser() enable_laser() n stop list() stop list() n restart list() restart list() n get xyz pos() get_xyz_pos() n_get_xy_pos() get_xy_pos() n select list() select list() n_z_out() z_out() n_laser_signal_on() laser_signal_on() n laser signal off() laser signal off() n set delay mode() set delay mode() n set piso control() set piso control() n select status() select status() n get encoder() get encoder() n select cor table() select_cor table() n execute at pointer() execute at pointer() n_get_head_status() get head status() n simulate encoder() simulate encoder() n_set_hi() set hi() n_release_wait() release_wait() n get wait status()

get wait status() n set ext start delay() set ext start delay() n home position() home_position() n set rot center() set rot center() n read ad x() read ad x() n read pixel ad() read pixel ad() n_get_z_distance() get z distance() n get time() get time() n set defocus() set defocus() n set softstart mode() set softstart mode() n set softstart level() set softstart level() n control command() control command() load cor() load pro() n get serial number() get serial number() n get serial number 32() get serial number 32() get hi data() n_auto_cal() auto_cal() n_get_list_space() get list space() teachin() n get value() get value() set_duty_cycle_table() n_move_to() move_to() getmemory() n get waveform() get waveform() n measurement status() measurement status() n load varpolydelay() load varpolydelay() n write da 2 list() write da 2 list()

9.3 USC1/2 Compatibility Functions (SCI interface)

Beside the easy programming interface described above a bunch of additional functions is provided that are compatible to the ones known from SCI programming interface used for USC1/2 scanner controller card. So to use E1701 scanner card with existing code that supports the USC1 or USC2 scanner controller, following steps have to be done:

 insert a call to E170X_set_connection() into existing code as very first in order to specify the communication connection for E1701 card (this is the only exception where an E1701 Easy Interface Function should be used together with an USC1/2 Compatibility Function)

• recompile the existing SCI-application so that it uses e1701inter.DLL instead of sc_optic.dll In case E1701 card has to be operated with default settings, no recompilation is necessary, here e1701inter.dll just has to be renamed to sc_optic.dll. Since most relevant SCI functions are already provided, majority of existing applications should work now without any further modifications. Due to the different concept of E1701 scanner controller, there are some differences to the original SCI programming interface which should be checked in case of troubles:

- all USC1/2 functions/types that exist as stream- and non-stream-variants are treated like a stream command
- output of already sent marking data is started on call to <code>ScSCIFlush()</code> latest
- some functions are not implemented or always return a default value (please refer below of a list of not implemented SCI functions)

Following functions are specific to USC1/2 hardware or do not make sense in relation to E1701 scanner card and therefore aren't supported. These functions exist in libe1701inter, but do not provide any functionality:

```
long ScSCISetContinuousMode()
long ScSCIGetContinuousMode()
long ScSCIDevicePixelLine()
long ScSCIRasterPixelLine()
long ScSCIRasterStart()
long ScSCIRasterEnd()
long ScSCIGetDeviceName()
long ScSCIGetDeviceCaps()
long ScSCIGetDeviceData()
long ScSCISetDeviceData()
long ScSCIGetExternalTrigger()
long ScSCISetExternalTriggerCount()
long ScSCIGetExternalTriggerCount()
long ScSCISetEnableHead()
long ScSCIGetEnableHead()
long ScSCISetZField()
long ScSCIGetZField()
long ScSCIGetZGain()
long ScSCISetZGain()
long ScSCIGetHomePosition()
long ScSCIGetZHomePosition()
long ScSCISetHomePosition()
long ScSCISetZHomePosition()
long ScSCIGetZOffset()
long ScSCISetZOffset()
long ScSCISetZWorkingArea()
long ScSCIGetZWorkingArea()
long ScSCIGetHomeJump()
long ScSCISetHomeJump()
long ScSCIMaxExternalTriggerCount()
long ScSCIResetExternalTriggerCount()
long ScSCISetDeviceEnableFlags()
long ScSCIGetDeviceEnableFlags()
long ScSCIGetDevicePath()
long ScSCISetDeviceMiscValueD()
long ScSCIGetDeviceMiscValueD()
long ScSCISetHeadCount()
long ScSCIStreamInfo()
long ScSCIGetSpeed()
long ScSCISetSpeed()
long ScSCIGetStyleSet()
long ScSCISetStyleSet()
long ScSCISetLoopMode()
long ScSCIGetLoopMode()
long ScSCISetLoop()
long ScSCIGetLoop()
long ScSCISetMessageWindow()
long ScSCISetAxisState()
long ScSCIGetAxisState()
```

```
long ScSCISaveSettings()
long ScSCILoadSettings()
long ScSCIEditSettings()
long ScSCIUpdateDeviceStyle()
long ScSCIGetInterfaceVersion()
long ScSCIGetDebugMode()
long ScSCISetDebugMode()
long ScSCIGetIdentString()
long ScSCIGetDeviceMapLaserPort()
long ScSCISetDeviceMapLaserPort()
long ScSCIGetUSCInfoLong()
```

9.4 OLSC Compatibility Functions (Open Laser Show Controller interface)

Beside the easy programming interface described above, a bunch of additional functions is offered that provide an OLSC v2 compatible programming interface. So to use E1701 scanner card with existing code that supports the Open Laser Show Controller interface, following steps have to be done:

- insert a call to E170X_set_connection() into existing code as very first in order to specify the communication connection for E1701 card (this is the only exception where an E1701 Easy Interface Function should be used together with an OLSC Compatibility Function)
- recompile the existing OLSC-application so that it uses e1701inter.DLL

In case E1701 card has to be operated with default IP 192.168.2.254, none of the above steps and no recompilation is necessary, here e1701inter.dll just has to be renamed to the name of the DLL of the target device.

Since most relevant OLSC v2 functions are already provided, majority of existing applications should work now without any further modifications. Due to the different concept of E1701 scanner controller, there are some differences to the original OLSC v2 programming interface which should be checked in case of troubles. So some functions are not implemented and therefore always return a default value (please check behaviour of these functions related to your application).

APPENDIX A – Wiring between E1701 and IPG YLP Series Type B, B1 and B2 fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using E1701A or E1701D Baseboard, LP8 Extension Board and optional Digi I/O Extension Board for laser alarms and pilot laser.

Signal Name	Board	Connector / Pin	IPG Pin
LPO	LP8 Extension Board	Pin 1	Pin 1
LP1		Pin 3	Pin 2
LP2		Pin 5	Pin 3
LP3		Pin 7	Pin 4
LP4		Pin 9	Pin 5
LP5		Pin 11	Pin 6
LP6		Pin 13	Pin 7
LP7		Pin 15	Pin 8
MO / Main Oscillator		Pin 8	Pin 18
LP8 Latch		Pin 17	Pin 9
LaserA / Frequency		Pin 22	Pin 20
Laser Gate /		Pin 26	Pin 19
Modulation			
LaserB		Pin 19	Pin 22 *)
Alarm,		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Din 14
one of DIn0DIn7	Digi I/O Extension		
Alarm,	Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 21
one of DIn0DIn7			
Pilot Laser: in			
software choose			
LaserB as output			

*) may require additional power driver since some laser variants consume a current at this input which is higher Than the maximum output allowed

In this wiring-scheme no GND-connections are listed, they have to be added in order to get valid and working connections.
APPENDIX B – Wiring between E1701 and JPT YDFLP series fiber laser ("MOPA") or IPG YLP Series Type D fiber laser or Raycus RFL PMX/PQB Series fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using E1701A or E1701D Baseboard, LP8 Extension Board and optional Digi I/O Extension Board for laser alarms and pilot laser.

Signal Name	Board	Connector / Pin	JPT D-SUB25 Pin		
LPO		Pin 1	Pin 1		
LP1 / serial data		Pin 3	Pin 2 ²)		
LP2 / serial clock		Pin 5	Pin 3 ²)		
LP3		Pin 7	Pin 4		
LP4		Pin 9	Pin 5		
LP5		Pin 11	Pin 6		
LP6	LP8 Extension Board	Pin 13	Pin 7		
LP7		Pin 15	Pin 8		
MO / Main Oscillator		Pin 8	Pin 18		
LP8 Latch	-	Pin 17	Pin 9		
LaserA / Frequency		Pin 22	Pin 20		
Laser Gate / Modulation		Pin 26	Pin 19		
LaserB / serial enable		Pin 19	Pin 22 ¹) ²)		
Alarm,		Din 4 4 9 10 12 14 14 or 19	Din 14		
one of DIn0DIn7	Digi I/O Extension	PIII 4, 0, 0, 10, 12, 14, 10 0r 10	PIII 10		
Alarm,	Board	Pin 4 6 8 10 12 14 16 or 18	Din 21		
one of DIn0DIn7		F III 4, 0, 0, 10, 12, 14, 10 01 10	FIIIZI		
Pilot Laser: in software					
choose LaserB as output					

¹) for details regarding double-usage of this pin, please refer to the manual of the laser

²) serial data transmission requires firmware version 28 or newer

APPENDIX C – Wiring between E1701 and IPG YLP Series Type E fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using E1701A or E1701D Baseboard, LP8 Extension Board and Digi I/O Extension Board for laser alarms and pilot laser with support for APD index setting via DB-25 serial data interface

Signal Name	Board	Connector / Pin	IPG Pin
LPO		Pin 1	Pin 1
LP1		Pin 3	Pin 2
LP2		Pin 5	Pin 3
LP3		Pin 7	Pin 4
LP4		Pin 9	Pin 5
LP5		Pin 11	Pin 6
LP6	LP8 Extension Board	Pin 13	Pin 7
LP7		Pin 15	Pin 8
MO / Main Oscillator		Pin 8	Pin 18
LP8 Latch		Pin 17	Pin 9
LaserA / Frequency		Pin 22	Pin 20
Laser Gate / Modulation		Pin 26	Pin 19
LaserB		Pin 19	Pin 22 ¹)
Alarm, one of DIn0DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 16
Alarm, one of DIn0DIn7	Digit/O Extension	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 21
Serial Enable	Digit/O Extension Roard	Pin 7	Pin 24 ²)
Serial Clock	Board	Pin 9	Pin 13 ²)
Serial Data		Pin 11	Pin 10 ²)
Pilot Laser: in software choose			
LaserB as output			

¹) may require additional power driver since some laser variants consume a current at this input which is higher than the maximum output allowed

²) serial data transmission requires firmware version 28 or newer

APPENDIX D – Wiring between E1701 and IPG YLP Series Type F fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Signal Name	Board	E1701D Connector / Pin	D-SUB25
LPO		Pin 1	Pin 1
LP1		Pin 3	Pin 2
LP2		Pin 5	Pin 3
LP3		Pin 7	Pin 4
LP4		Pin 9	Pin 5
LP5		Pin 11	Pin 6
LP6	I D9 Extension Board	Pin 13	Pin 7
LP7	LPO EXTENSION DOALD	Pin 15	Pin 8
MO / Main Oscillator		Pin 8	Pin 18
LP8 Latch		Pin 17	Pin 9
LaserA / Frequency		Pin 22	Pin 20
Laser Gate / Modulation		26 pin connector, pin 26	Pin 19
LaserB		Pin 19	Pin 22
GND		Pin 2 or 23	Pin 14
Alarm, one of DIn0DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 11
Alarm, one of DIn0DIn7	Digi IO Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 16
Alarm, one of DIn0DIn7		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 21
Pilot Laser: in software choose			
LaserB as output			

APPENDIX E – Wiring between E1701 and IPG YLR Series laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Signal Name	Board	Connector / Pin	IPG Pin
AOut0		Pin 10	Pin 12 ¹)
MO / Main		Din 9	Din 19
Oscillator	LP8 Extension Board	FIIIO	PIII 10
Laser Gate /		Din 26	Dip 15
Modulation		FIIIZO	FIIIIJ
Pilot Laser,			
one of	Digi I/O Extension Board	Pin 3, 5, 7, 9, 11, 13, 15 or 17	Pin 17
DOut0DOut7			

¹) maximum analogue output voltage of LP8 extension is limited to 5V while this laser type expects 0..10V range. So this voltage needs to be doubled by some external equipment, elsewhere the laser can be driven with a maximum of 50% power only

APPENDIX F – Wiring between E1701 and SPI G4 Pulsed Fibre Laser / TRUMPF TruPulse nano series

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant 1: waveform selected via LP8 outputs of LP8 Extension Board, simmer, power and extended parameter control via laser controller plug in/serial interface:

Signal Name	Board	Connector / Pin	SPI Laser		
			Connector Pin		
LP0		Pin 1	Pin 17		
LP1		Pin 3	Pin 18		
LP2		Pin 5	Pin 19		
LP3		Pin 7	Pin 20		
LP4		Pin 9	Pin 51		
LP5		Pin 11	Pin 52		
LP6	I D9 Extension Roard	Pin 13	Pin 53		
LP7	LF O Extension Board	Pin 15	Pin 54		
MO / Laser Enable		Pin 8	Pin 7		
LP8 Latch		Pin 17	Pin 23		
LaserA / Pulse		Din 22	Din 47		
Trigger		P11122	PIII 47		
Laser Gate /		Din 24	Din 5		
Modulation		FIII20	FIIIJ		
Alarm,		Pin 4 6 8 10 12 14 16 or 18	Din 9		
one of DIn0DIn7	_		1 111 7		
Pilot Laser,	Digi I/O Extension Board				
one of DOut0		Pin 3, 5, 7, 9, 11, 13, 15 or 17	Pin 6		
DOut7					

Variant 2: waveform selected via digital outputs of Digi I/O Extension Board, simmer, power and extended parameter control via laser controller plug in/serial interface:

Signal Name	Board	Connector / Pin	SPI Laser		
			Connector Pin		
DOut0		Pin 3	Pin 17		
DOut1		Pin 5	Pin 18		
DOut2		Pin 7	Pin 19		
DOut3		Pin 9	Pin 20		
DOut4	Digit (O Extension Board	Pin 11	Pin 51		
DOut5	Digi I/O Extension Board	Pin 13	Pin 52		
DOut6		Pin 15	Pin 53		
DOut7		Pin 17	Pin 23		
Alarm,		Din 4 4 9 10 12 14 14 or 19	Din 9		
one of DIn0DIn7		PII14, 0, 0, 10, 12, 14, 10 0F 10	PIII 7		
Pilot Laser,		Din 1 2 5 7 0 11 12 or 15	Din 4		
one of LP8_0P8_7		PIII 1, 5, 5, 7, 7, 11, 15 0F 15	PIIIO		
MO / Laser Enable		Pin 8	Pin 7		
LaserA / Pulse	LP8 Extension Board	Din 22	Din 47		
Trigger		F11122	FIII4/		
Laser Gate /		Din 24	Din E		
Modulation		P11120	PIIID		

Variant 3: waveform selection, simmer, power and extended parameter control via laser controller plug in/serial interface:

Signal Name	Board	Connector / Pin	SPI Laser Connector Pin
MO / Laser Enable		Pin 8	Pin 7
LaserA / Pulse Trigger	I P8 Extension Board	Pin 22	Pin 47
Laser Gate / Modulation		Pin 26	Pin 5
Alarm, one of DIn0DIn7	Digi I/O Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 9
Pilot Laser, one of LP8_0LP8_7 or one of DOut0 DOut7	LP8 Extension Board or Digi I/O Extension Board	Pin 1, 3, 5, 7, 9, 11, 13 or 15 or Pin 3, 5, 7, 9, 11, 13, 15 or 17	Pin 6

APPENDIX G – Wiring between E1701 and Raycus fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using E1701A or E1701D Baseboard, LP8 Extension Board and optional Digi I/O Extension Board for laser alarms and pilot laser.

Signal Name	Board	Connector / Pin	Raycus DB25 Pin	
LP0		Pin 1	Pin 1	
LP1		Pin 3	Pin 2	
LP2		Pin 5	Pin 3	
LP3		Pin 7	Pin 4	
LP4		Pin 9	Pin 5	
LP5		Pin 11	Pin 6	
LP6	LP8 Extension Board	Pin 13	Pin 7	
LP7		Pin 15	Pin 8	
MO / Main		Din 9	Din 19	
Oscillator		FIIIO	F III 10	
LaserA / Frequency		Pin 22	Pin 20	
Laser Gate /		Din 24	Din 10	
Modulation		FIII20		
Alarm,		Pin 4 6 8 10 12 14 16 or 18	Din 16	
one of DIn0DIn7	Digil/O Extension Board	FII14, 0, 0, 10, 12, 14, 10 01 10		
Alarm,		Pin 4 6 8 10 12 14 16 or 18	Din 21	
one of DIn0DIn7		F III 4, 0, 0, 10, 12, 14, 10 01 18		

APPENDIX H – Wiring between E1701 and MaxPhotonics MFP fiber laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using E1701A or E1701D Baseboard, LP8 Extension Board and optional Digi I/O Extension Board for laser alarms and pilot laser.

Signal Name	Board	E1701x Pin	MaxPhotonic s DB25 Pin
LPO		Pin 1	Pin 1
LP1		Pin 3	Pin 2
LP2		Pin 5	Pin 3
LP3		Pin 7	Pin 4
LP4		Pin 9	Pin 5
LP5		Pin 11	Pin 6
LP6	LP8 Extension Board	Pin 13	Pin 7
LP7		Pin 15	Pin 8
LP8 Latch		Pin 17	Pin 9
MO / Main Oscillator		Pin 8	Pin 18
LaserA / Frequency		Pin 22	Pin 20
Laser Gate / Modulation		Pin 26	Pin 19
GND		Pin 2 or 23	Pin 10-15
Alarm,		Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 16
one of DIn0DIn/			
Alarm, one of DIn0DIn7	Digi I/O Extension Board	Pin 4, 6, 8, 10, 12, 14, 16 or 18	Pin 21
Pilot Laser, one of DOut0 DOut7		Pin 3, 5, 7, 9, 11, 13, 15 or 17	Pin 22

APPENDIX I – Wiring between E1701 and DAVI D-Series RF CO_2 Laser

PLEASE NOTE: this wiring scheme is a non-binding policy, it may be incorrect due to changes in connected hardware. So in every case please check this table against specification and wiring documentation of the used laser!

Variant using E1701A or E1701D Baseboard and optional Digi I/O Extension Board for laser alarm.

Signal Name	Board	E1701x Pin	DAVI RJ45 Pin	DAVI RJ45 Wire Colour	
LaserA / Frequency	F1701x Basebaard	13	1	orange/white	
GND	E1701X Baseboard	14	8	brown	
Laser Ready input, one of		Pin 4, 6, 8, 10,	2	groop/white	
DIn0DIn7	Digi I/O Extension Board	12, 14, 16 or 18	3	green/white	
GND		2	6	green	

APPENDIX J – IDC connector pin numbering

Pin numbering of the IDC connectors (according to pinout-tables shown in hardware description sections above) can be seen in below image:



The first pin is marked by a small arrow in connector. Second pin is below of it, counting continues column-wise.

These connectrors itself are standard IDC connectors with 2,54 mm contact spacing.

APPENDIX K - E1701D XY2-100 protocol description

The data submitted at 26 pin connector of E1701D are conform to XY2-100 specification:



In standard 16 bit operating mode first three bits are set to 001, then 16 bit position data followed by a parity bit (even parity) are transmitted:

19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	1	D15D0 position data									Pe							

In enhanced XY2-100 18 bit operating mode first bit is set to 1, then 18 bit position data followed by a parity bit (odd parity) are transmitted:

19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
1	D17.D0 position data									Po									

To use this mode, the related tune-value has to be set in configuration file (please refer to section "6.1.8 microSD-Card"), this mode requires firmware version 24 or newer

APPENDIX L - E1701D XY3-100 protocol description

Depending on the actual configuration, the data submitted at 26 pin connector of E1701D are conform to XY3-100 specification. For details about the XY3-100 protocol, please contact HALaser Systems.

APPENDIX M - E1701D SL2-100 protocol description

The E1701D does not yet support the serial SL2-100 protocol. For further information please contact HALaser Systems.

APPENDIX N - E1701D RL3-100 protocol description

The E1701D does not yet support the RL3-100 protocol. For further information please contact HALaser Systems.

APPENDIX O – Board dimensions

E1701A/E1701D board dimension drawings (baseboard plus optional extension boards), all values are given in unit mm.



 ${\sf X}$ – for future compatibility leave additional space of 10 mm at Ethernet connector side of the controller

E170Xbase dimension drawing, all values are given in unit mm.



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